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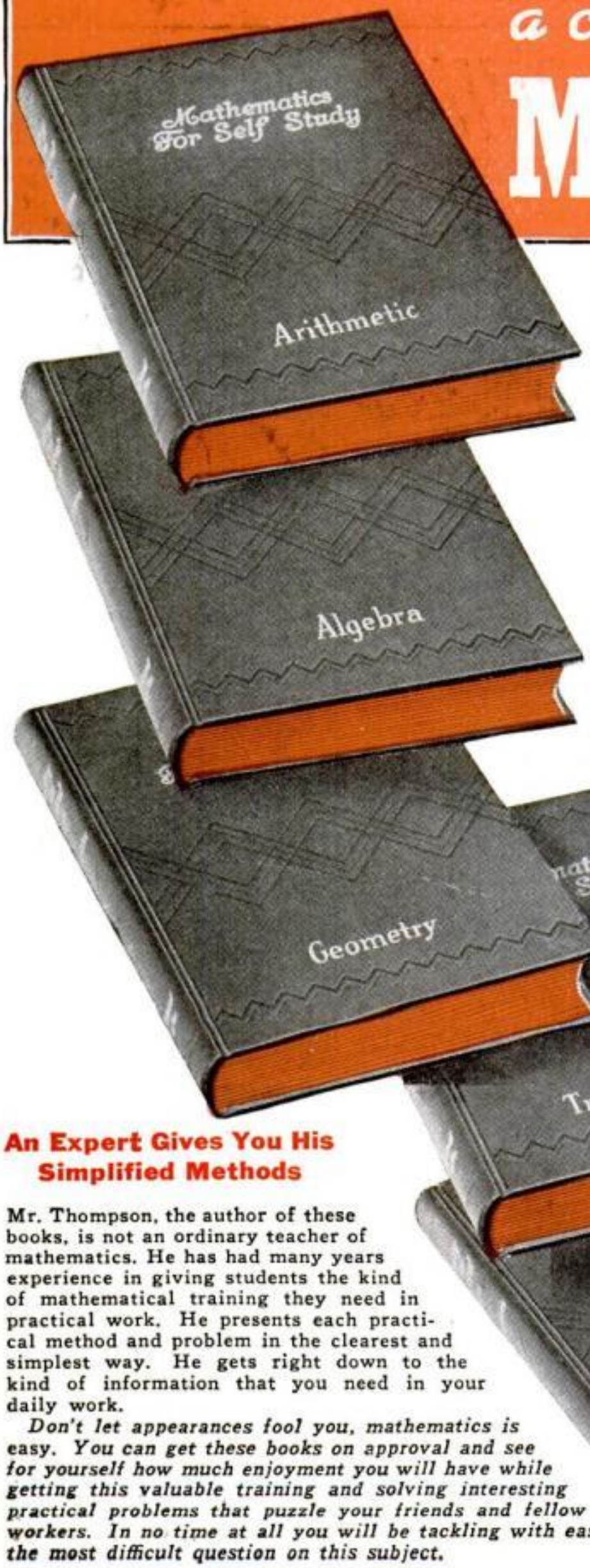


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*(Continued on next page)*

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**by J. E. Thompson, B.S. in E.E., A.M., Dept. of Mathematics, Pratt Institute**

*(Continued from facing cover)*

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# POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 141 NO. 1

**Mechanics & Handicraft**

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY


## CONTENTS for JULY, 1942

### News



### Automobiles



### Home and Workshop



### Departments




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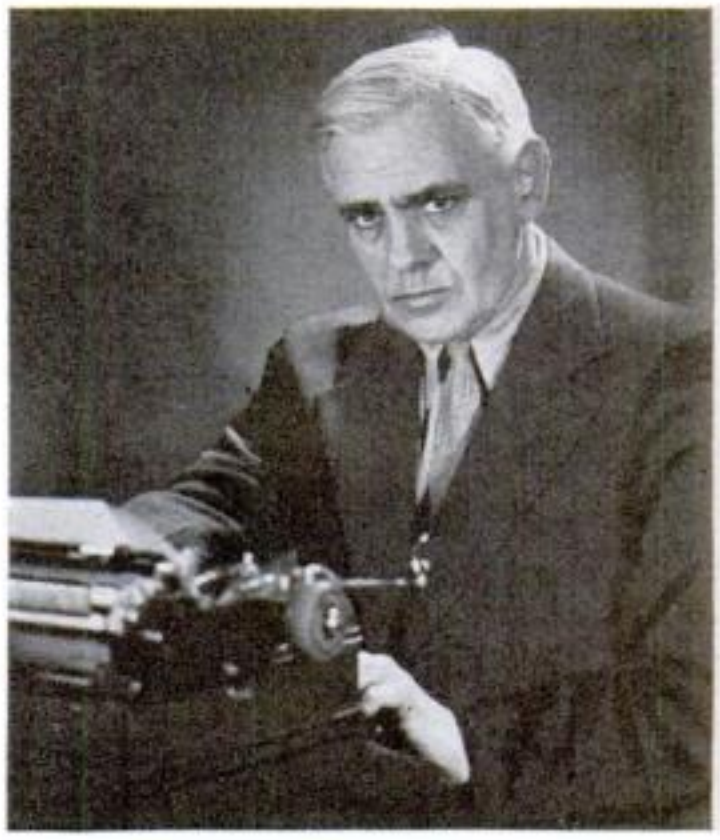

HERBERT ASBURY ("Inventor for Victory," page 89) is a veteran newspaper and magazine writer. Worked 18 years on leading dailies in New York and other cities. Has written stories and articles for many magazines. Went to Hollywood and wrote a half dozen movies. Since 1928 he has written 15 books, latest of which is "The Golden Flood," a history of America's first oil field in Pennsylvania.




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# Contents [CONTINUED]

## Automobiles



## Aviation



## Facts and Ideas



## Inventions



*(Continued on page 6)*

# A Message of Confidence

THE WAR has brought many changes to the Bell System. The nation needed telephone facilities in new places. It needed more facilities in the usual places. It needed all those facilities in a hurry.

Shortages of essential materials brought new problems and new achievements in research and in manufacturing. Telephone calls increased about ten million a day.

Yet all this has been done without great change in your telephone service. Millions of subscribers have felt no difference. The record as a whole has been good. That is the way it should be and the Bell System aims to keep it that way.

But when war needs delay your call, when you can't get just the service or equipment you need, let's put the blame right where it belongs — on the war.

**Bell Telephone System**

*Service to the Nation in Peace and War*

# Contents [CONTINUED]

## Photography



## Craftwork



## Home Building



## Miscellaneous



## New Shop Ideas



*(Continued on page 8)*

# WHEN and HOW to Use Your FLASHLIGHT in a BLACKOUT

## THESE INSTRUCTIONS Reviewed and Passed by the OFFICE OF CIVILIAN DEFENSE

**1 EVERY HOME** should have one or more flashlights! But before buying *new* ones, inspect and repair your *old* ones. They may need only a new bulb, new lens or fresh batteries.

**2 KEEP YOUR FLASHLIGHT** in a convenient, accessible place —and *always* in its place. When using it INDOORS, never point it toward unshielded windows, skylights or open doors.

**3 DO NOT USE** an *unshielded* flashlight OUTDOORS in a blackout except when absolutely necessary. Keep the beam level or downward—never point it even *slightly* upward. And never point it toward highly reflective surfaces.

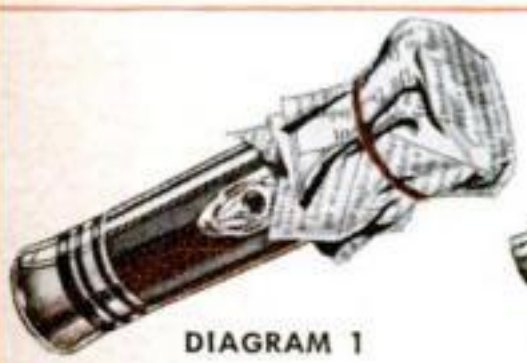

DIAGRAM 1

DIAGRAM 2

**4 HERE'S HOW TO SHIELD** your flashlight for outdoor use: Cover lens with two thicknesses of newspaper or similar paper, held in place by string, as in Diagram 1. OR, cut two discs of paper and insert under lens, as in Diagram 2. Deep red paper may also be used (blue is unsatisfactory). **CAUTION: The Office of Civilian Defense has not yet approved any so-called "blackout lights."** To be safe, follow the instructions given here, *until further instructions are issued.*

**KEEP FLASHLIGHTS LOADED** with fresh batteries, and have an extra set on hand for your light in case of long-continued use.

**THE FOREGOING INSTRUCTIONS ARE PUBLISHED FOR YOUR AID AND GUIDANCE**

We hope you will never meet with an emergency, but if you do, we hope you will have *fresh* "Eveready" batteries in your flashlight, because we know they will not fail you. Fresh, DATED "Eveready" batteries last longer.

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**FRESH BATTERIES LAST LONGER...**
*Look for the* **DATE-LINE**

# Contents [CONTINUED]

# Coming Next Month —

WHIRLING RINGS OF AIR, shot for long distances from curious "guns," may provide the solution for the problem of clearing the soot-laden air above big cities and industrial centers. While they resemble the rings blown by smokers, their possible application to practical work is no pipe dream. An article describes the amazing laboratory feats they have performed.

DRILLING TINY HOLES in diamonds is one of the vital tasks in winning the war. Diamond dies, pierced with holes smaller than a human hair, are essential for drawing the spider-web wires used in delicate aviation and fire-control instruments. How America was nearly caught short in this war-production "must," and how a highly specialized industry was created almost overnight, makes a thrilling story.

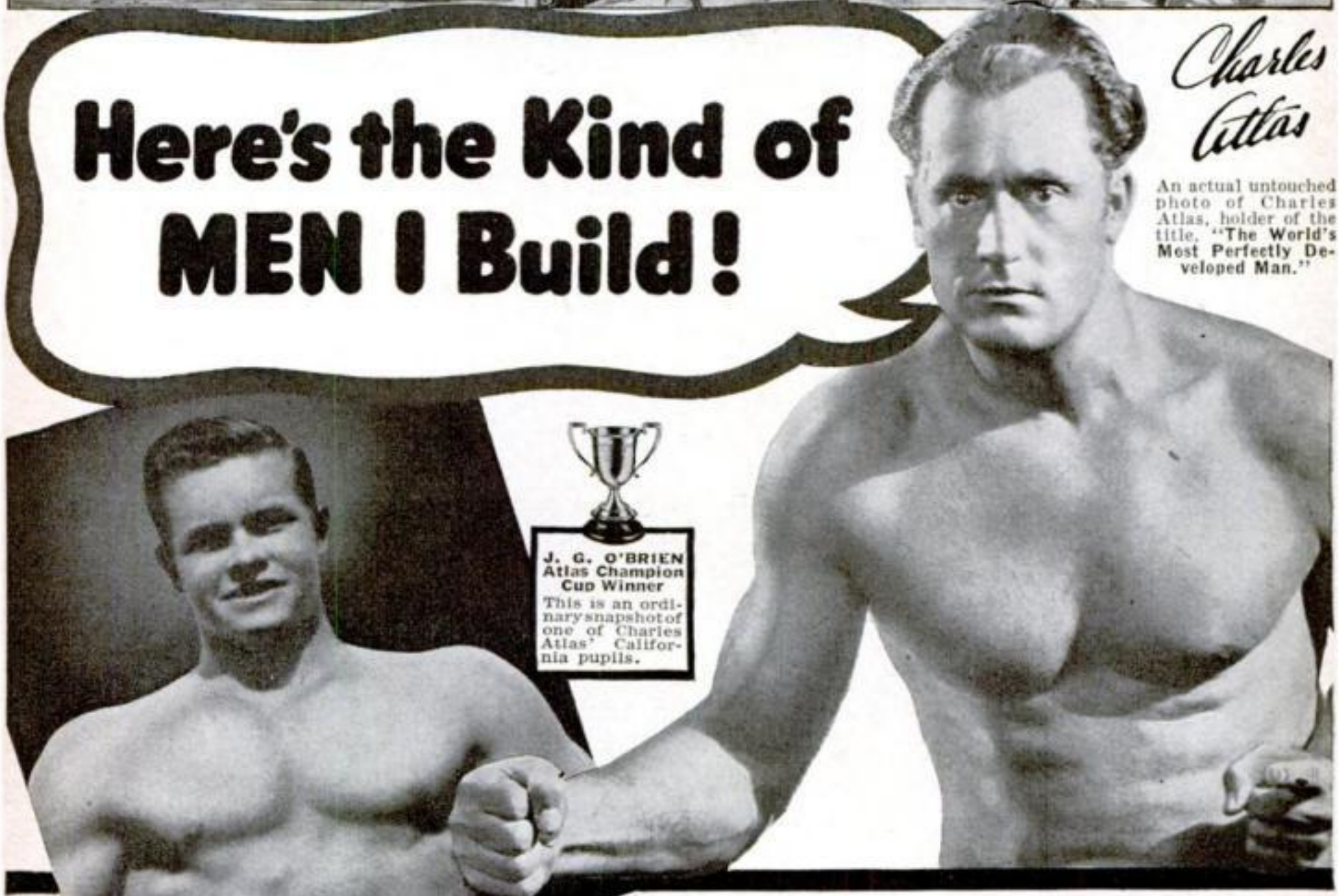
YOU'LL BE SURPRISED to see the useful and attractive articles that readers have fashioned from tin plate salvaged from cans, in the contest conducted recently by this magazine. The prize-winning projects, which are illustrated and described, testify to the patience and ingenuity of their makers and will suggest many other uses of this handy material.

FLAME THROWERS paced the lightning German advance through France in 1940. For breaking the resistance of concrete emplacements and pillboxes they are an accepted weapon of modern assault tactics. How do they work, and how are they used? What is our own Army doing about them? These questions are answered in an article that tells you what you want to know about this spectacular tool for making it hot for the enemy.

CUTTING COMPOUNDS and lubricants for machine tools are assuming new importance for the operators of small machine shops. Tough, tool-resistant alloys specified for Army and Navy equipment cannot be worked efficiently unless the proper coolant or cutting oil is fed to the point of contact between tool and work. What these magic fluids are, and how they are used for best results, is told in a practical article.

YOUR GLOVES are things you take for granted. But there's an interesting story behind the tanning of the leather and the fashioning of it into something that fits like a glove. We sent a writer and a photographer to the center of America's glove industry to bring you a word-and-picture account of a time-honored craft that has been handed down for generations.


# Here's the Kind of MEN I Build!



Charles Atlas

An actual untouched photo of Charles Atlas, holder of the title, **"The World's Most Perfectly Developed Man."**

**J. G. O'BRIEN**
**Atlas Champion Cup Winner**
This is an ordinary snapshot of one of Charles Atlas' California pupils.

# Will You Let Me PROVE I Can Make YOU a New Man?

I DON'T care how old or young you are, or how ashamed of your present physical condition you may be. If you can simply raise your arm and flex it I can add SOLID MUSCLE to your biceps—yes, on each arm—in double-quick time! Only 15 minutes a day—right in your own home—is all the time I ask of you! And there's no cost if I fail.

I can broaden your shoulders, strengthen your back, develop your whole muscular system INSIDE and OUTSIDE! I can add inches to your chest, give you a vise-like grip, make those legs of yours lithe and powerful. I can shoot new strength into your old backbone, exercise those inner organs, help you cram your body so full of pep, vigor and red-blooded vitality that you won't feel there's even "standing room" left for weakness and that lazy feeling! Before I get through with you I'll have your whole frame "measured" to a nice, new, beautiful suit of muscle!

## What's My Secret?

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## Only 15 Minutes a Day

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From the News Editor's Desk

TO DETERMINE whether a person gets enough B vitamins or not, a simple test has been devised in which the subject goes on a 12-hour, overnight fast. At the end of the thirteenth hour, he is tested to determine whether he still is excreting vitamins through his kidneys. If the test shows a good surplus, his diet is probably furnishing him with enough, but if it does not, he probably needs to take more. So far, the test has been limited to three of the B vitamins—thiamin, riboflavin, and nicotinic acid.

BARK WOOL, a product made from the short fibers of redwood bark combined with natural wool, is the newest fabric designed to alleviate the wool shortage. In the process of making the new fabric, the combined fibers of the redwood and the natural wool are carded, combed, and spun into yarn. The yarn is then woven or knitted into fabrics which are said to have the same properties as pure woolen textiles. Combining wool with from 15 to 60 percent redwood bark fiber enables a substantial saving in wool and makes the final product much less expensive.

GLASS FIBERS, compressed and treated with a binder, offer a new blast-cushioning, noncombustible material for blacking out war production plants. Designed to reduce damage from concussion and from fire caused by incendiary bombs, the material is rigid enough to be self-supporting although it can be faced with glass-fiber cloth, plywood, or other surfacing materials. While its concussion-absorbing properties cannot provide protection against near-by blasts, they will absorb part of the shock of more distant explosions, which can prove highly destructive in industrial plants.

SNOWPROOF GOGGLES which exclude ultraviolet and infrared rays have recently been perfected by the Army Quartermaster Corps. Developed for ski troops and mountain fighters, these new goggles have rounded triangular lenses which are shielded with "side windows" to keep the snow from the wearer's eyes. A special adjustment across the bridge prevents the glasses from sliding up and down on the face. They may be folded into a small triangular case which the soldier can carry in his pocket.

A NEW ELECTROPLATING PROCESS makes it possible to plate tin cans with half the amount of tin, in half the time, and with less electric power. Instead of the alkaline base usually employed in this type of electroplating, the method uses a neutral solution which is said to eliminate sludge and the consequent waste of tin. Announced recently by E. I. du Pont de Nemours and Company, the new process gives a thinner and more uniform coat which saves from 40 to 65 percent of the tin used in the conventional method.

# DRAFTSMEN NEEDED Now

Industry is clamoring for more draftsmen, for the job can't start until plans are drawn. Buildings, airplanes, machines, guns, tanks, bridges, all start on the drafting board, so it's no wonder that every good draftsman has a fine job. Yes, more draftsmen are needed NOW. The pay is good and the opportunities for advancement great.

## Learn at Home in Spare Time

Begin now to turn spare hours into money. Be a draftsman, the connecting link between a mechanic and an engineer. Enjoy the wonderful opportunities for promotion that exist now. No experience or artistic talent is needed. You don't have to leave your present job while learning. Use spare time.

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**$10 a Week Extra in Spare Time**

I am doing spare time Radio work, and I am averaging $500 a year—the difference between just barely getting by and living comfortably. — JOHN WASHKO, 97 New Cranberry, Hazleton, Penna.

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# Readers Say:

## A Fine Time to Bring This Up —When We're Busy Shooting

MAYBE I ought to know this, but I don't. Will some wise guy explain it? A shell is fired by a naval gun at 45 degrees or some other angle from the horizontal. Owing to the gyroscopic motion imparted by the rifling of the gun, it is supposed to keep nose-first and not turn sidewise. Now, when it lands on the Jap battleship (we hope) is the shell still pointing upward at an angle of 45 degrees, or has it lowered its nose so that it points downward in the direction it is going when it lands? If its nose has changed to a downward angle, what caused the change, since the gyroscopic force was in action all the time? And don't say that the action of the air caused it; how would the air know which way you wanted the shell to go? —T. L. W., Jr., Dallas, Ga.


## Would Put P.S.M. Readers to Work Thinking Up Defensive Weapons

I HAVE just been reading the May issue of your magazine, and the article on the "Porcupine Squadron" is very thought-provoking. It appears that our Army and Navy have plenty of men daily designing more and more deadly weapons to use on the enemy. And, no doubt, the enemy is devising equally deadly ones to use on us. But it appears to me that not enough is being done to devise weapons to prevent damage by enemy weapons. For example, it does not seem there is yet any effective weapon against airplanes. Newspaper reports exult when a dozen enemy planes, out of a group of 200 or 300, are shot down—and most of these are not destroyed by antiaircraft guns. POPULAR SCIENCE readers are among the most intelligent in the world. So why not encourage them to devise means to prevent air raids; the weapons we have so far seem able only to spoil the enemies' aim. Similar encouragement might develop some excellent anti-submarine defenses, too. I'm sure POPULAR SCIENCE readers will rise to the occasion and produce something worth while if properly stimulated. Think it over.—C. E. G., Chicago, Ill.

## He Suggests a New Twist for Vacuum Bottles

WILL some bright boy please advise the manufacturers of vacuum bottles that their product could be improved by putting right-hand threads on the cup and left-hand threads on the joint that holds the bottle together? I recently purchased a vacuum bottle that has very few right-hand threads on the cup, and very few more right-hand threads on the delicate material fastening the bottle in the container. Every mid-shift lunch time, we have profanity, fun, and more profanity! Try to take off the cup without taking the bottle apart. The cup sticks to the bottle. If you try to hold the bottle by hand to remove the cup, you get cut; if you use pliers, the too-thinly tapped threads flatten out. Seems to me that a left-hand thread on the bottle (leaving a right-hand thread on the cup, of course) would solve the problem—and save the wife's temper at home, too, when she packs the lunch.—F. L. A., Vallejo, Calif.


## Shop Tools of the 1870's Awaken Old Memories

YOUR reference to W. F. and John Barnes scroll saws, in your 70th Anniversary home-workshop feature, stirs up some old memories. In the middle 70's two of my friends had Barnes saws, one with the bicycle drive like your illustration, and the other with a ratchet drive. A little later I had one of their wood-turning lathes which had a bed of two pieces of maple on which a previous owner had put two pieces of planed bar iron. About 1888, I bought one of their No. 5 metal-turning lathes, and still have it. Two of my friends have No. 4½ metal-turning lathes. All have seats and are driven by a shaft with two or three cranks, according to length. For most of my work I like the foot power, but I have fitted a motor drive which I use for long jobs or wood turning, as it is easier on my legs.—A. L. F., North Easton, Mass.

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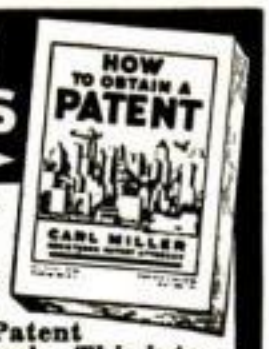


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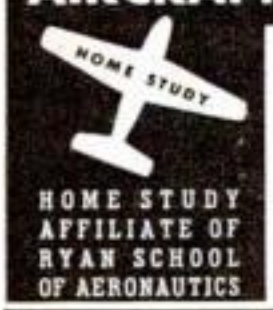


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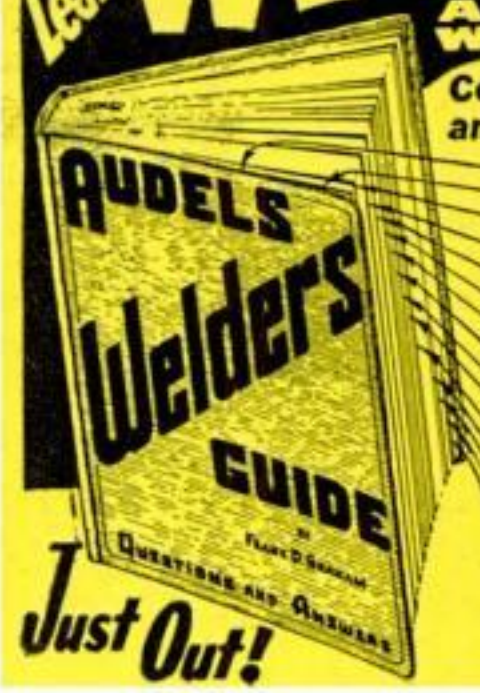


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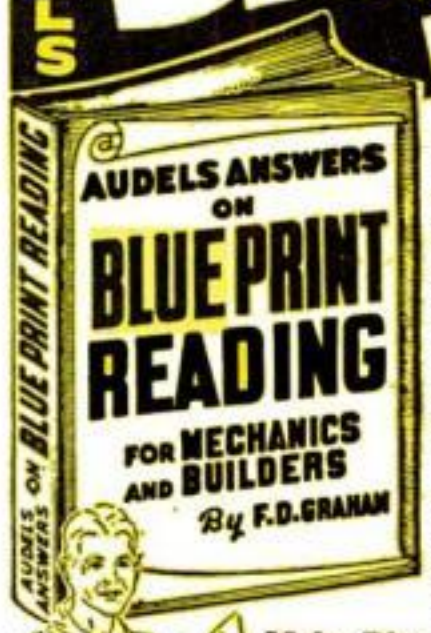


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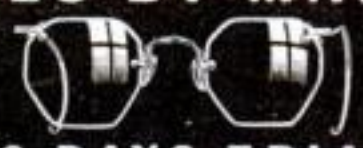

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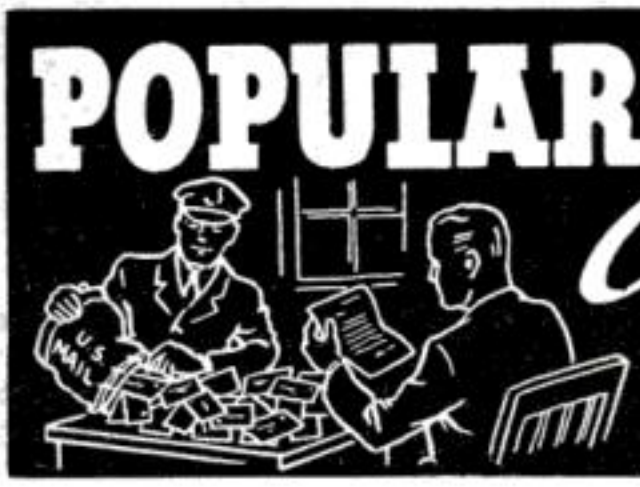

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**Classified Ads only 35c per word per insertion, payable in advance. Minimum ad 10 words. To be included in August issue copy should be in our office by June 9th. August issue on sale July 1.**
**POPULAR SCIENCE MONTHLY—351 FOURTH AVE.—NEW YORK CITY**

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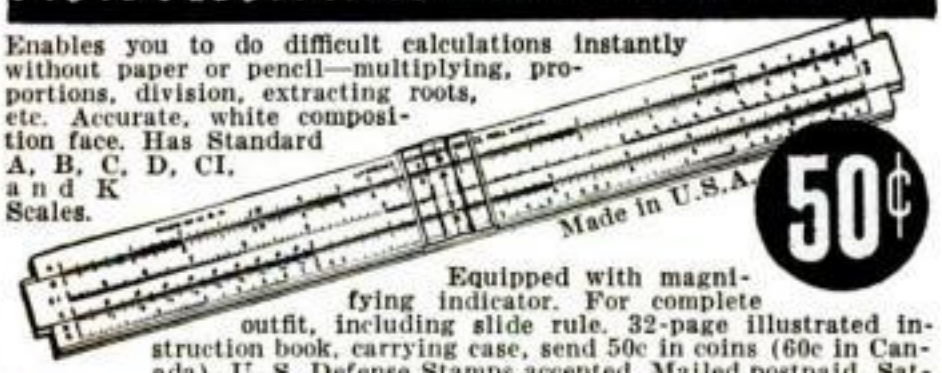


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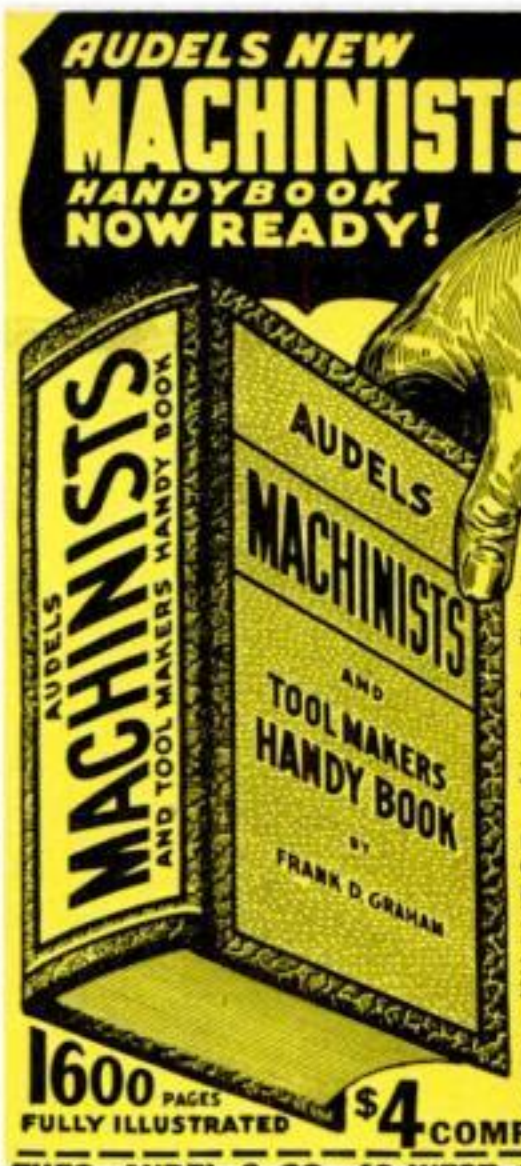


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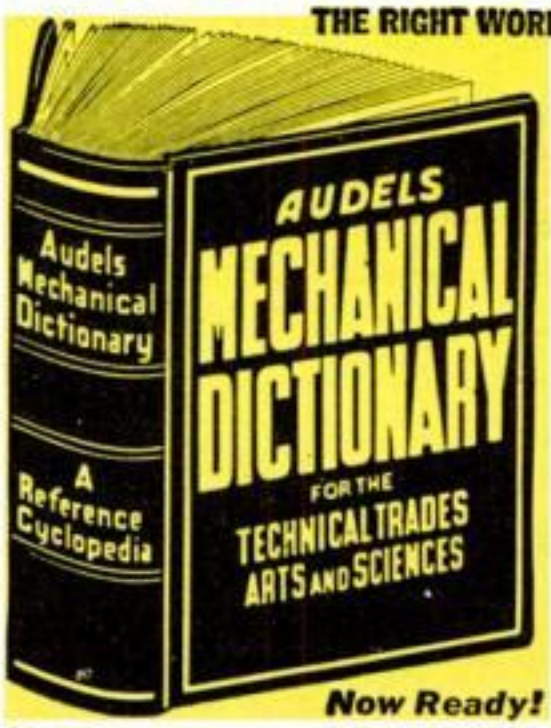


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Magnetism made visible in a striking view of iron-filing patterns around a gear-shaped (left) and circular magnet

# SUPERMAGNETS

## NEW ALLOYS GIVE US MIGHTY MIDGETS FOR WAR AND INDUSTRY

ALMOST every day both war and civilian industry are discovering new uses for magnets and working out new techniques for their application to manufacturing and assembly problems. The supermagnet, a midget permanent type of comparatively recent development, is in such demand that the alloys of which it is made are being rationed, and there is no immediate prospect of an adequate supply. Manufacturing plants are using that old stand-by, the electromagnet, for work which only a few years ago would have been regarded as outside its range of possibilities. For example: Two plates for a cargo ship lie side by side, ready to be welded together. In the usual method, an eye bolt would first be welded to one of them, so

These two pieces of metal look innocent enough, but when they are joined together as shown at the left it takes a strong man to pull them apart by hand. The magnet is in the larger piece. Such assemblies are made to show the strength of new-type magnets

that a bar could be used to work the plate against the other. After the plates were joined, the eye bolt would be cut off, and the rough surface ground smooth.

But something new is happening here. A welder lowers an electromagnet over the gap between the plates and turns on the current. Under an invisible but irresistible force of 5,000 pounds, the heavy plates slide into tight contact. Then the worker tacks them together with his welding tool. He moves on to the next point of misalignment, and repeats the simple operation. His welding machine easily supplies the small amount of current needed to energize the magnet. In this labor-saving way, one man does the work of two, and in half the time—one of the reasons for ever-improving speed records in turning out new vessels for Uncle Sam's merchant marine.

On aircraft assembly lines, another kind of electromagnet boosts production of American warplanes. This ring-shaped magnet encircles an air hammer, used for setting rivets. Inside the plates being joined, the magnet centers and holds in place a "bucking bar" against which each rivet is flattened. With this aid, one man can set a rivet anywhere a mouse can crawl.

In few cases do electromagnets and permanent magnets compete with each other. Each has special advantages for certain jobs.

Just as long as current flows through the coils of an electromagnet, and no longer, its core of soft iron attracts things. With an electric switch, you can turn its magnetism on or off at will. That is why electromagnets suit the purposes just described, and serve to lift scrap iron from a pile and dump it into a waiting truck.

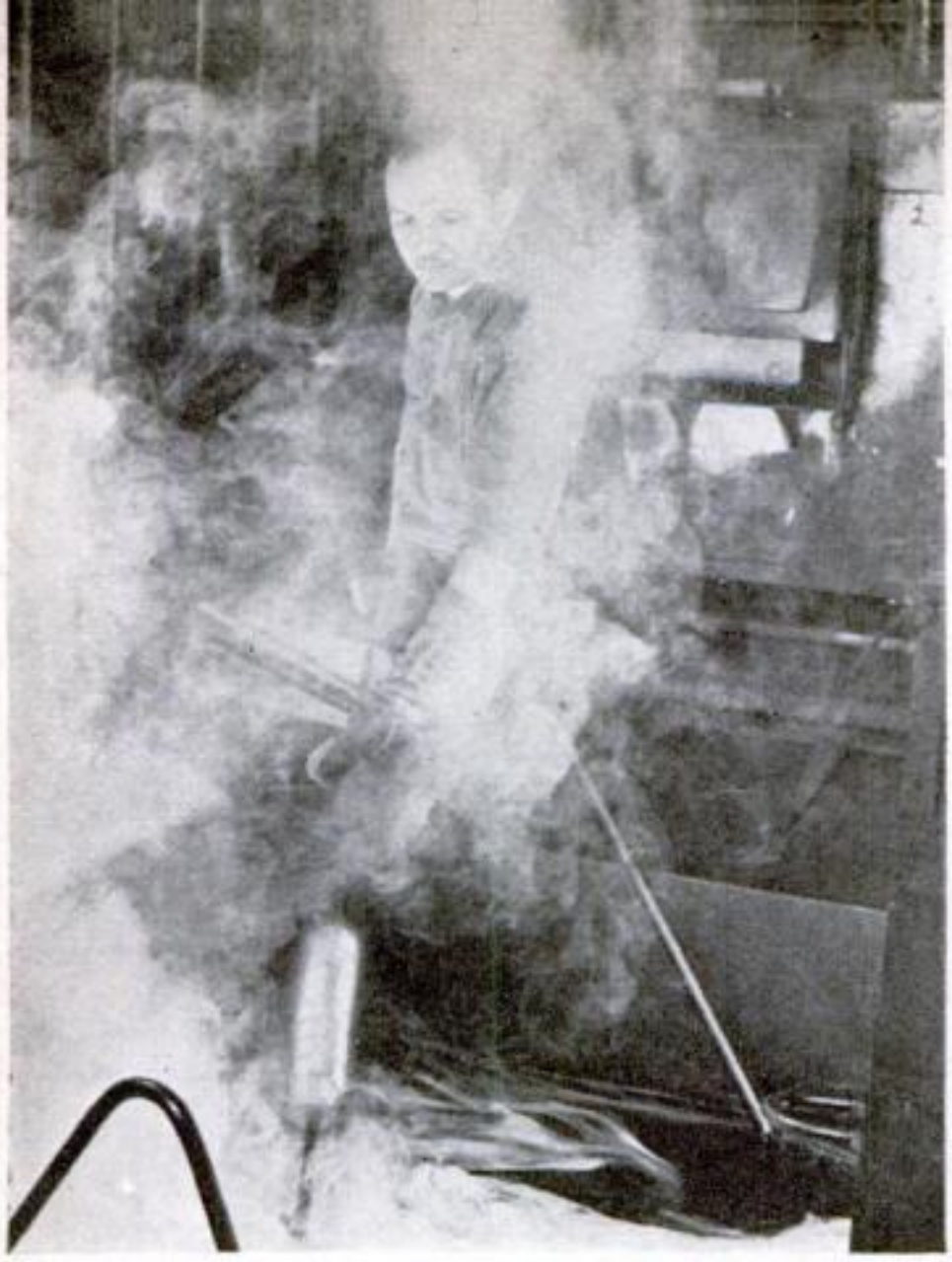
Permanent magnets, in contrast, don't let go. Once magnetized, they stay that way. Toy horseshoe magnets, and those of a motorcycle's magneto, are permanent magnets. They offer the advantage, often of prime importance, that they require no outside source of power. They are entirely self-contained, with no trailing wires.

Formerly permanent magnets were produced by alloying tungsten or chromium with iron, and magnetizing the hard steel that resulted. Compared with electromagnets, they had puny strength. Then, a few years ago, the General Electric Company announced a striking laboratory curiosity.

One of its metallurgists, seeking a heat-resisting metal, had tried alloying iron with certain proportions of aluminum, nickel, and cobalt. In due course, a sample went through

## Rating a Magnet's Power

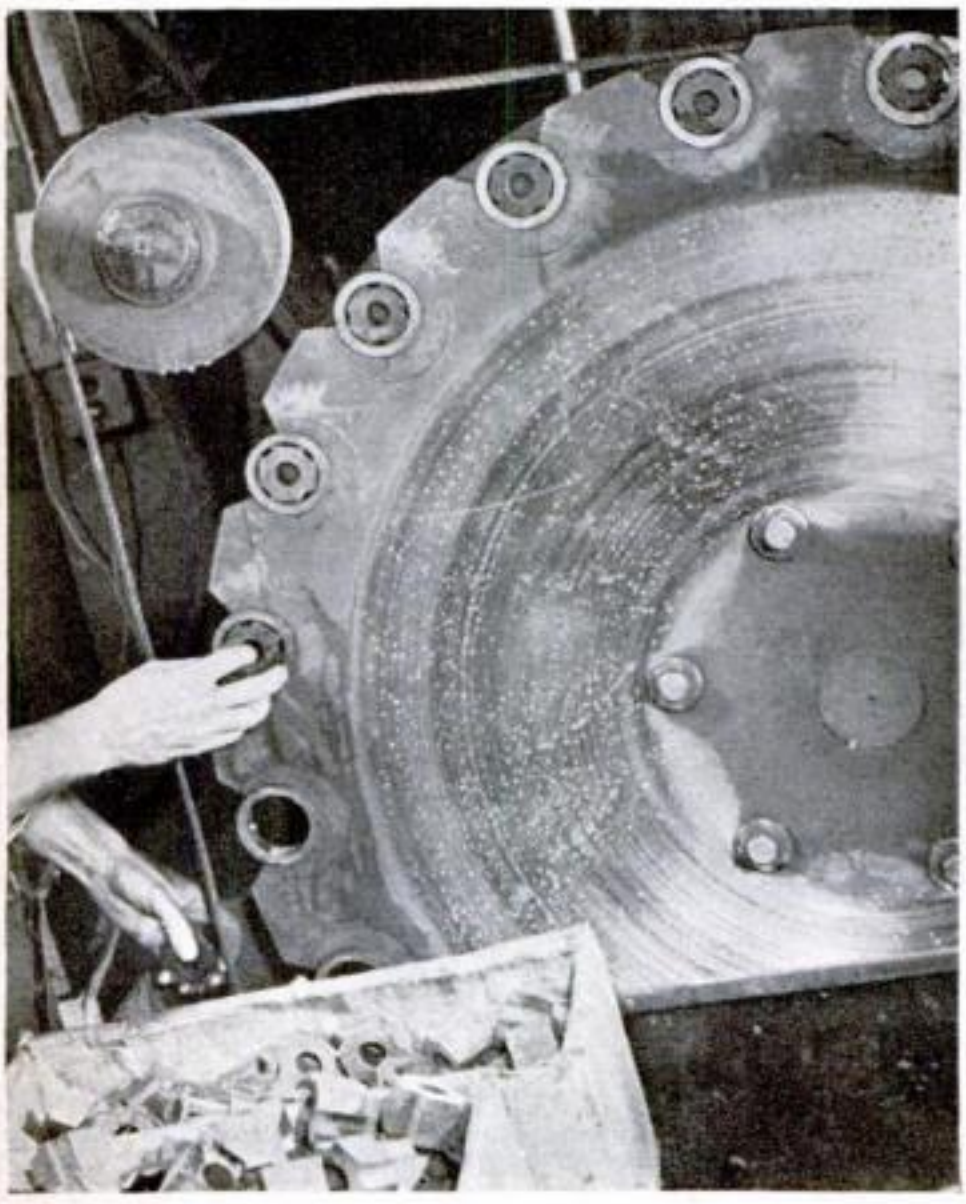
How do scientists gauge a magnet's strength? Their unit for expressing the intensity of a magnetic field is called the gauss. The terrestrial magnetism that acts horizontally upon a compass needle at Washington, D. C., equals about 0.18 gauss. Artificial magnetic fields up to 300,000 gauss have been produced experimentally.

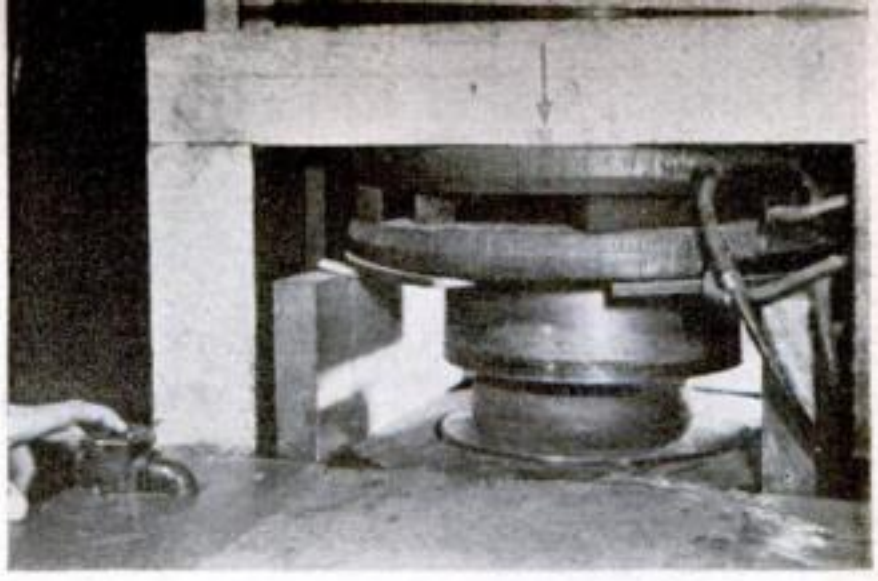


# Making a Magnet

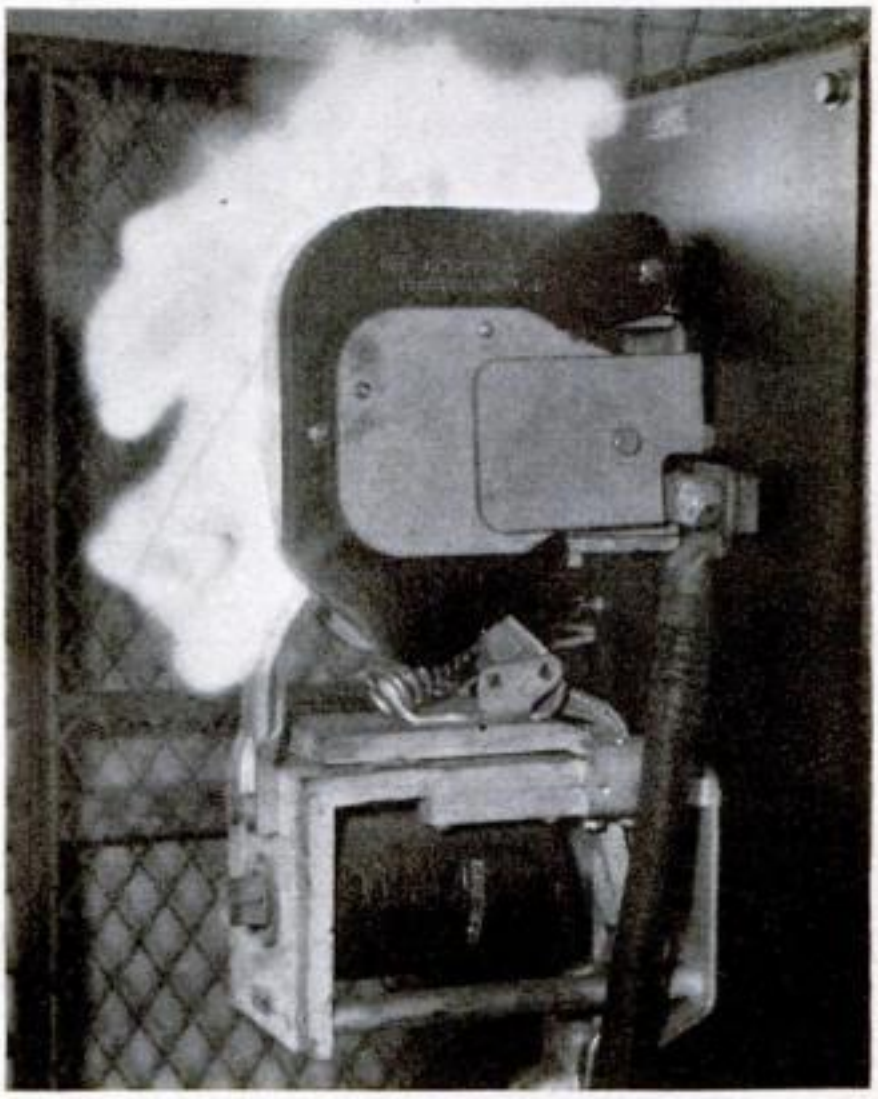
**1** Alloys are heat-treated for hardness to insure lasting magnetic strength. Here castings red-hot from the furnace are quenched in an oil bath

**2** Rough faces are ground off castings, below, on a special wheel with adapters set in circular slots designed to handle magnets of various sizes



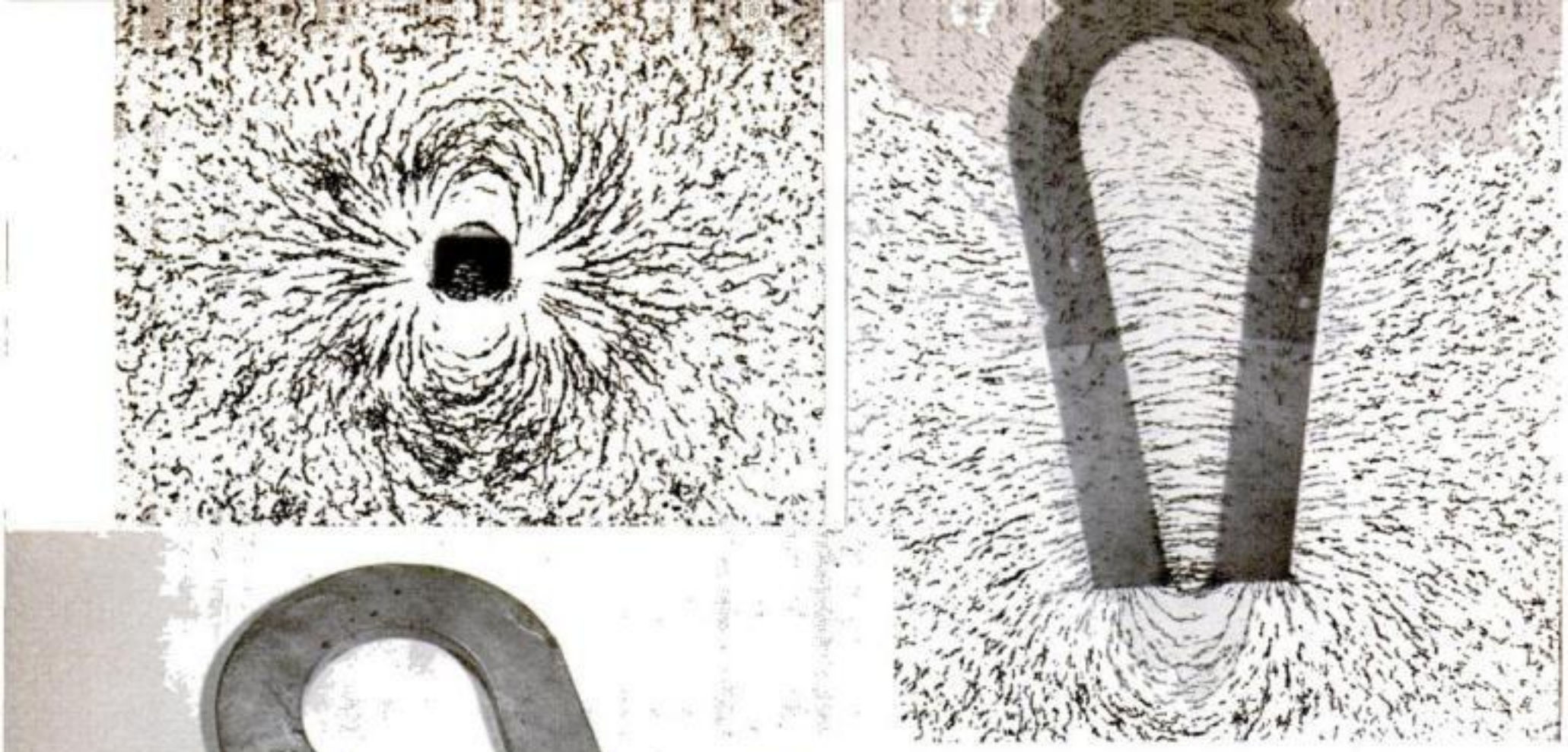


**3** Putting in the magnetism: Metal pieces become magnets in a fraction of a second between the poles of this powerful device when the current is turned on. Here one of the biggest types of magnet, for use in a radio loudspeaker, is being magnetized



**4** Bang! A dazzling arc and a noise like a cannon cracker show the power of the 260-ampere current flowing through the magnetizer coils when a remote-controlled switch breaks the circuit. This split-second job magnetizes the piece permanently

**5** And this is the finished product. The big ring magnet is now ready to help in reproducing the sounds of voice and music in a radio loudspeaker



The old-fashioned horseshoe magnet and the tiny-U-shaped magnet made with a new alloy, shown with it at left, can each just lift the steel cylinder. In doing so, the horseshoe supports less than twice its weight; the midget, 25 times its weight

a routine check-up of all its physical properties. To the surprise of all concerned, the alloy proved to be a magnet maker's dream, for it could be fashioned into permanent magnets of extraordinary power. Combining the first pairs of letters of its alloying ingredients, its discoverers named it "Alnico." Just about the same time, as often happens in the history of invention, research workers elsewhere chanced upon similar highly magnetic alloys, differing mainly in the ratio of their ingredients.

Today, supermagnets made of these alloys have found a host of uses. One outstanding application has been in portable radio sets using battery power. By taking the place of electromagnets, a permanent magnet of the new type eliminates need for current to maintain the magnetic field of the loudspeaker. Saving power consumption, this greatly prolongs the life of the dry cells.

Aircraft instruments, telephone equipment, and a wide variety of motors and generators have been improved by these mighty midgets among magnets. They find employment in prospecting with "treasure finders" or mineral locators, and in seismographs. Tachometers, outboard-motor magnetos, and hearing aids have been bettered by their use.

In beauty parlors, they make an easy task of removing hairpins. In metal-working operations, where a magnetic chuck holds the work in position for operations such as grinding, permanent magnets now vie with electromagnets; a hand control shifts them to a nonoperative position to release the work.

A magnetic lock for the battery case of a miner's electric headlamp has given supermagnets one of their oddest jobs. Since a man's life depended on this light, he was entitled to half an hour's time off whenever it needed repair or replacement. The temptation of this respite from toil proved too much for some miners, who found it a simple matter to open the battery case, tamper with the connections, and report a headlamp out of order. A cure was found in a special battery case which was passed over a magnetic fixture on a wall, tripping an internal latch, as each miner went on duty. Then the case could not be opened until the returning worker repassed it, in the opposite direction, over the same fixture. The epidemic of lamp trouble promptly subsided.

If magnets of the new type are kept from turning, they will exhibit strong repulsion as well as attraction. A New York City dentist, Dr. Hyman Freedman, has applied the fact to keep artificial teeth in place. Upper and lower plates both have small permanent magnets embedded in the ends, in such a way that the magnets gently repel each other. The resulting force, this dentist says,

solves the difficult problem of holding the lower plate where it belongs when it cannot be anchored to natural teeth.

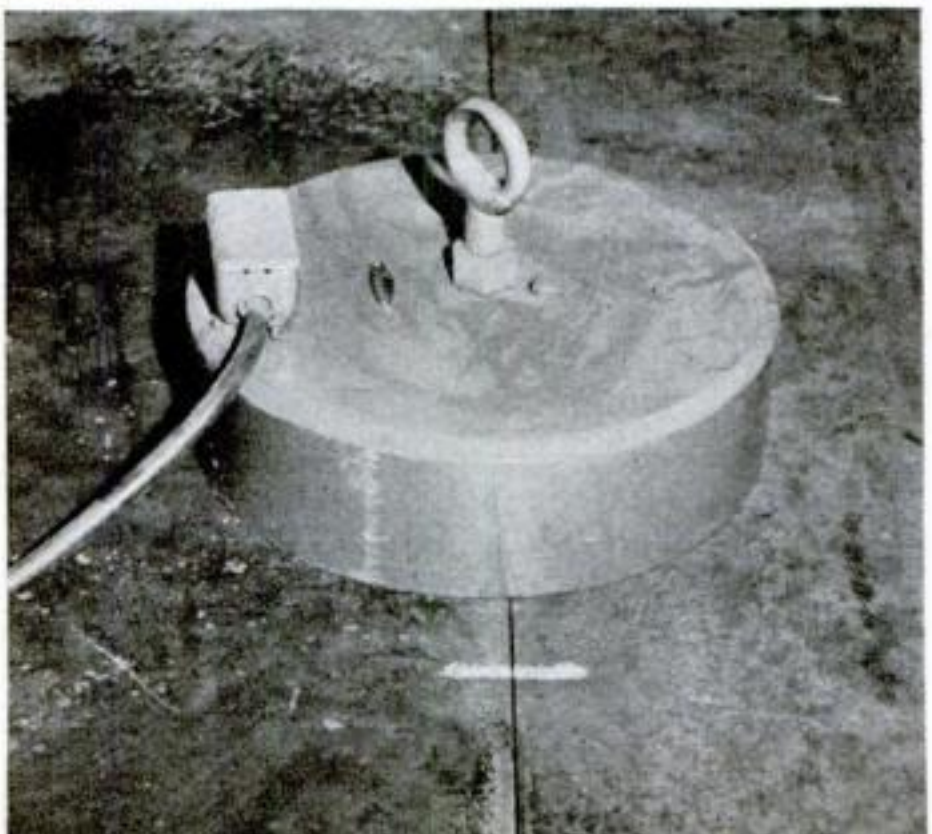
Unusual glimpses of the manufacture and remarkable properties of permanent supermagnets are given in the photographs on pages 41-44, made especially for POPULAR SCIENCE MONTHLY at the Stamford, Conn., plant of the Cinaudagraph Corporation. This concern manufactures them under its own patents and, by license, under those of the General Electric Company. At once their small size strikes the eye—an attribute made possible by their giant strength. In a rough-and-ready trial, a tiny U-shaped supermagnet proved the equal in lifting power of an old-fashioned horseshoe magnet many times its size, as illustrated. When designed for the purpose, supermagnets are reported to lift 50 or 60 times their own weight in regular use; and in special mountings, according to the General Electric Company, they hold 4,500 times their own weight.

Equally revealing are the lines of force around the supermagnets, made visible by the familiar artifice of sprinkling iron filings about them. Note the concentration of intense magnetic force in compact space by the supermagnet, as compared with the horseshoe magnet, in some of the accompanying photos.

These views are the finest of the kind that the writer has seen, and the method of making them—believed original with William Morris, staff cameraman—may be passed along for the benefit of amateur science photographers. Each magnet was sandwiched between two horizontal sheets of ground glass. Iron filings (20 mesh) were sprinkled evenly over the top surface, which then was gently tapped to bring out the pattern. The design was then photographed from above, by illumination both from top and bottom. This permitted the lighting to be adjusted so that even the filings within each magnet's silhouette were clearly visible.

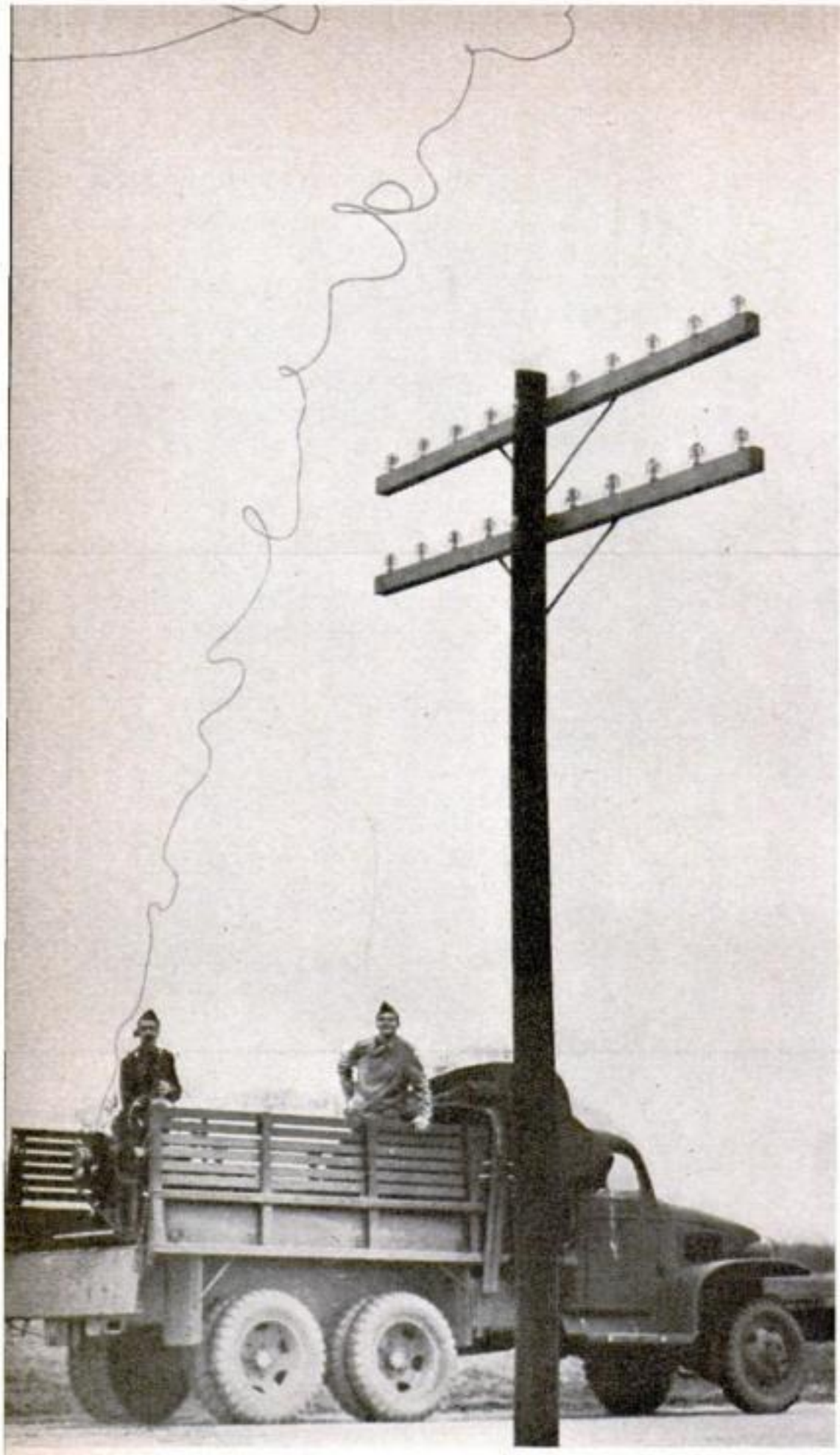
## Electromagnets Help Metalworkers Build Ships and Planes

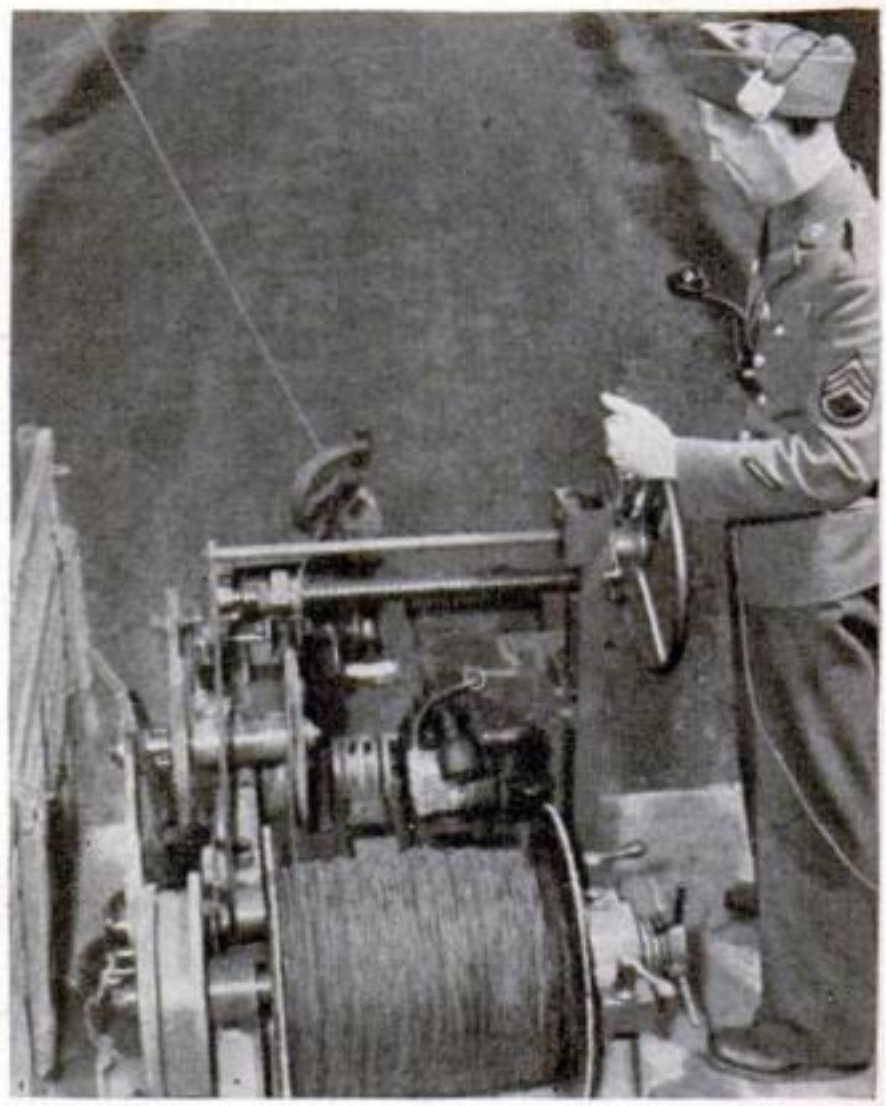
Steel plates for cargo ships are brought together for welding by the 5,000-pound pull of an electromagnet, as shown at the left. In the upper picture, the plates lie side by side and the magnet is lowered onto the gap. As the current is turned on, the heavy plates slide together and the welder tacks them up. This replaces slow hand alignment and enables one man to do work that formerly required two



On aircraft assembly lines, another kind of electromagnet boosts plane production. Built around an air hammer, it sends its attraction through plates at hard-to-reach points, holding a bucking bar for flattening the rivets

# Wire Thrower





AT 30 MILES AN HOUR, telephone wire is laid along a roadside from the rear of a truck. The operator of the machine talks to the driver through a breast phone

TO CLEAR OBSTACLES, wire can be thrown as high as 40 feet in the air as shown at the left. A gasoline engine provides the power for casting out the wire

LAYING a mile of telephone wire in two minutes is a simple three-man job with the Army's new wire-throwing device. This 600-pound machine, usually mounted on a 2½-ton truck, literally squirts wire along a roadside at the rate of 30 to 35 miles per hour. By adjusting the angle of a special ejector, the line can be thrown as high as 40 feet in the air in order to clear obstacles.

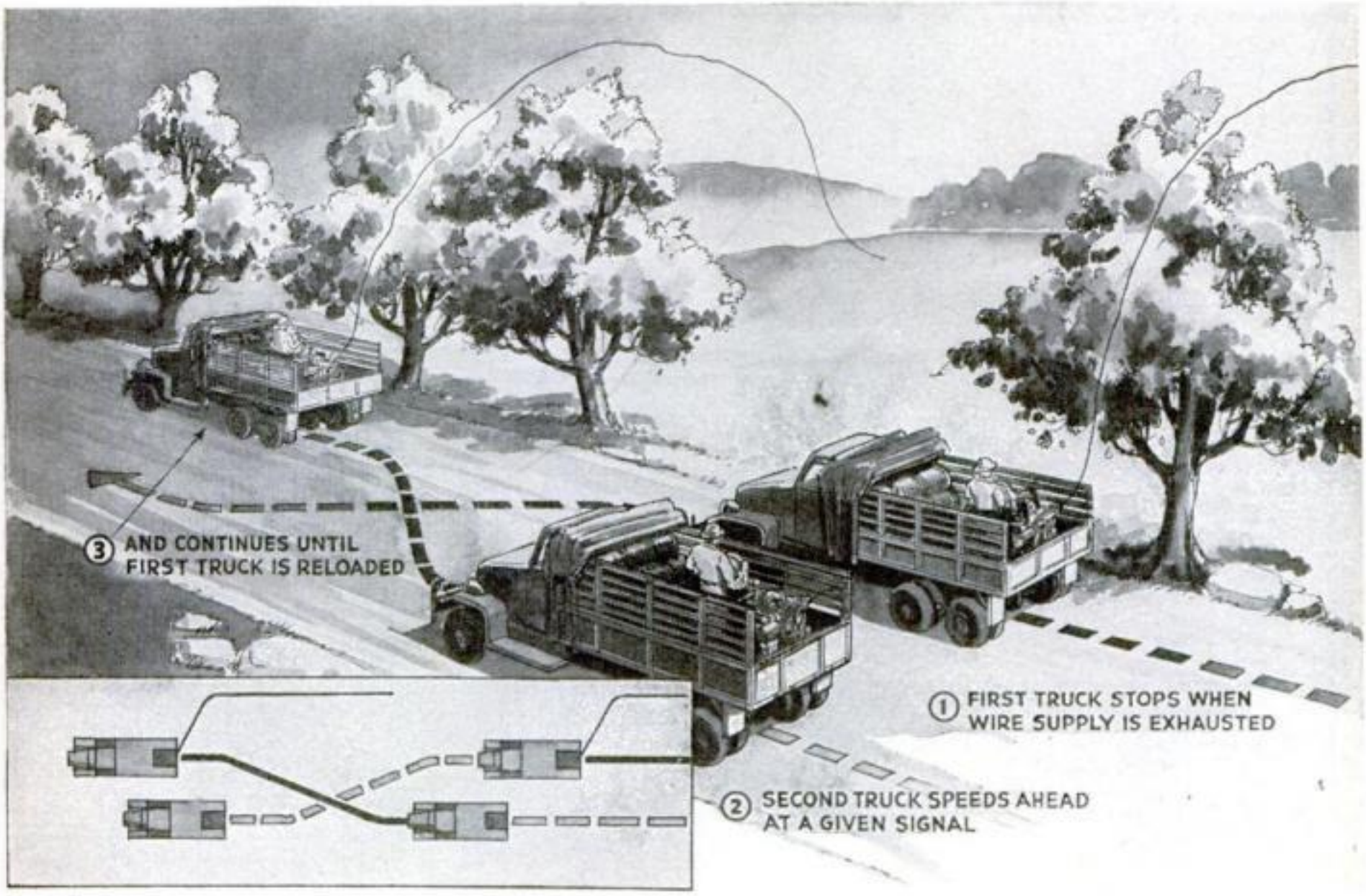
A reel carrying one mile of telephone wire rests in a special cradle on the back of the machine. The wire is threaded through a tension and guide pulley to take up slack. From here it passes between two rollers which resemble a small washing-machine wringer. A hollow, right-angle fin guides the flow of wire either up or down or from one side of the road to the other. The direction of this fin can be controlled by a wheel located next to the operator of the machine.

When the wire has been threaded, the operator starts a five-horsepower gasoline engine, phones to the truck driver to proceed, and then begins to squirt out the wire. The engine is connected to a centrifugal clutch which engages when the engine is accelerated and automatically disengages when throttled down. Wire can be rewound on the reel by unthreading the ejector and running the reel backward.

As shown in the illustration on the opposite page, two trucks equipped with the machines can do a continuous job of wire laying, one taking over when the other has emptied a reel.

Invented by a staff sergeant in the Coast Artillery, the machine has been developed by the Signal Corps and is now in actual production.

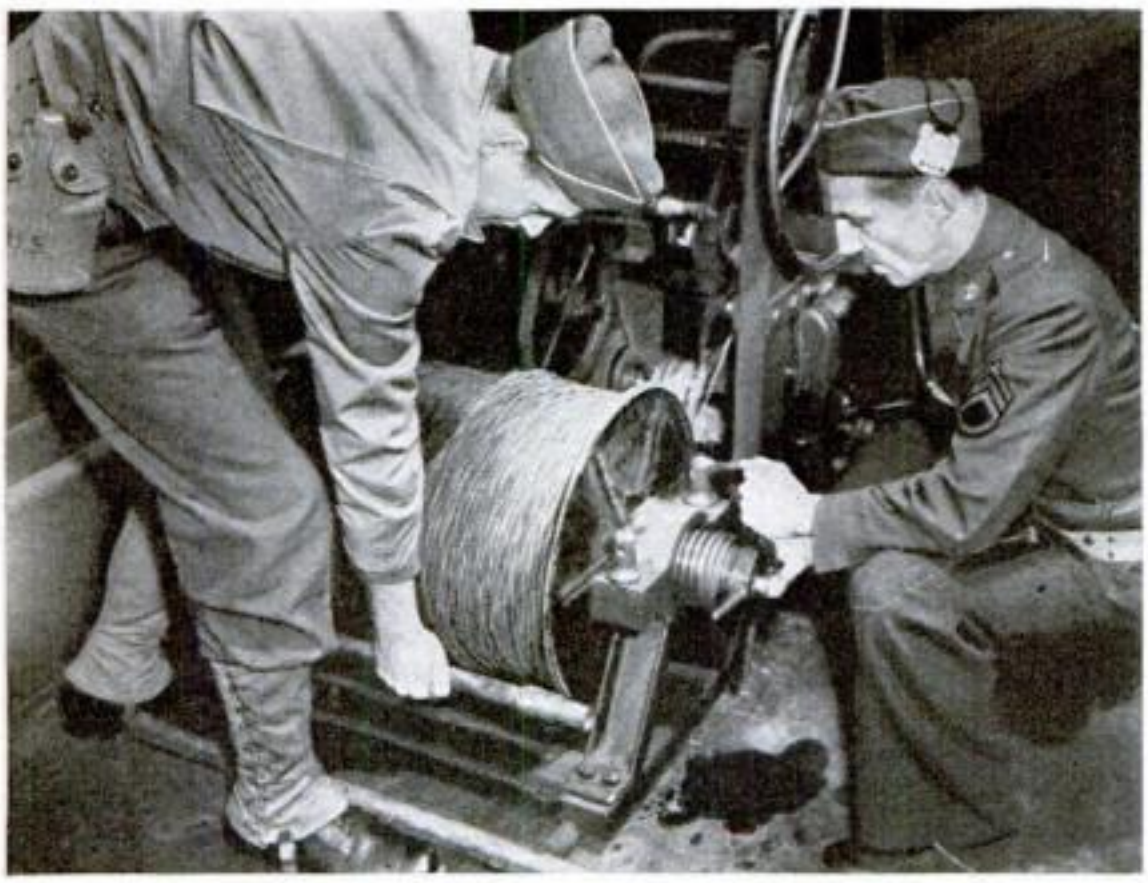
# Lays Army Telephone Line

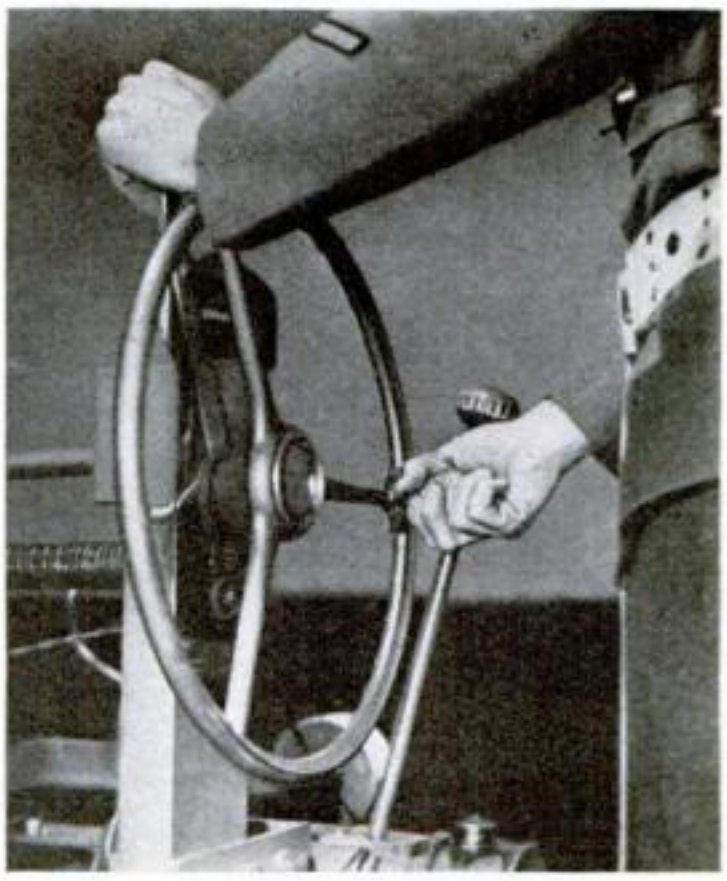


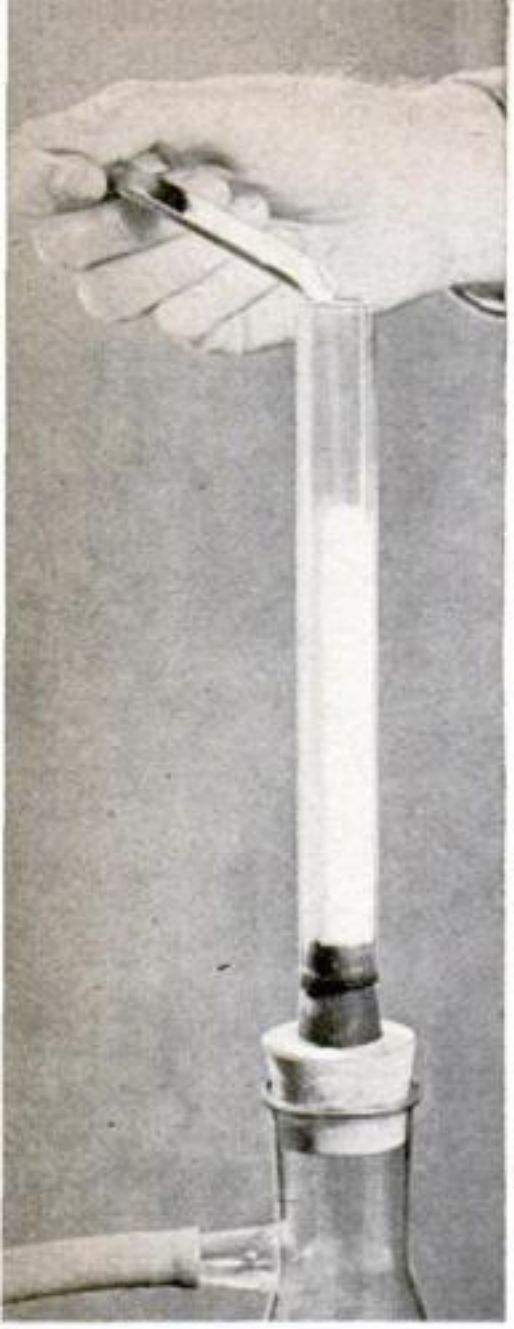

WORKING AS A TEAM, two trucks can lay 50 or 60 miles of wire without stopping. When one has used up a mile-long reel, the other pulls ahead and shoots back the end of a full reel for connection. Then it goes ahead, while the crew of the other mounts a new reel on its own machine for the next change-over

PUTTING IN A NEW REEL takes only a minute or two. The empty spool is removed from the cradle and a full one put in its place. Then wire is threaded through the ejector

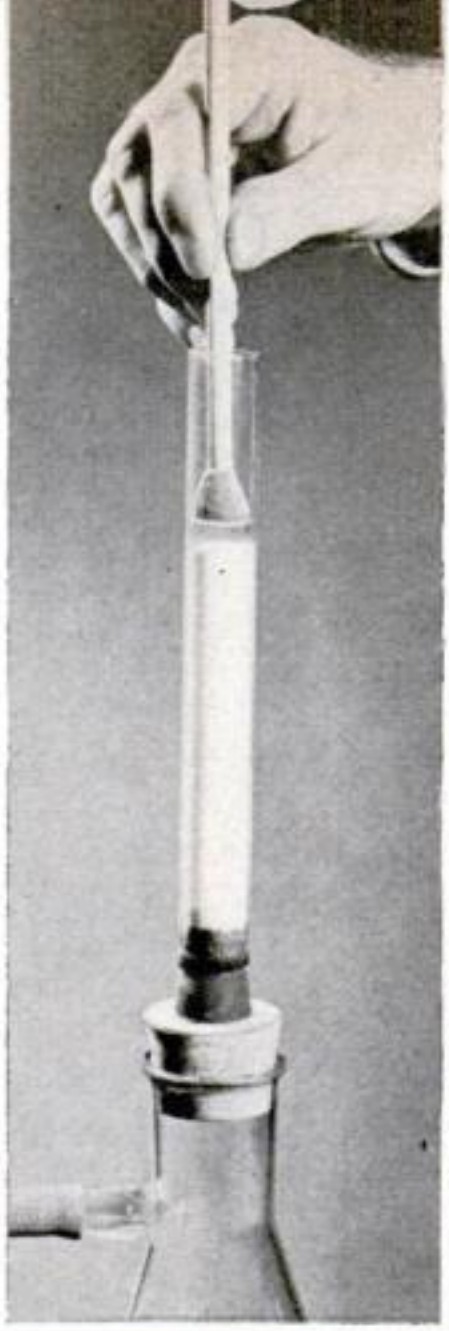
THIS WHEEL in the hands of the operator controls the guide fin that feeds the wire to the right or left, up or down







Activated alumina, or other adsorbent, is poured into a tube set into a filter flask . . .



. . . and packed uniformly by tapping the sides and tamping down from the top as shown above.

With a disk of filter paper above the packed adsorbent, gentle suction is applied and a solution of the material to be analyzed is poured in. Dr. H. A. Frediani, of Eimer & Amend, demonstrates here

# CHEMICAL ANALYSIS BY COLOR

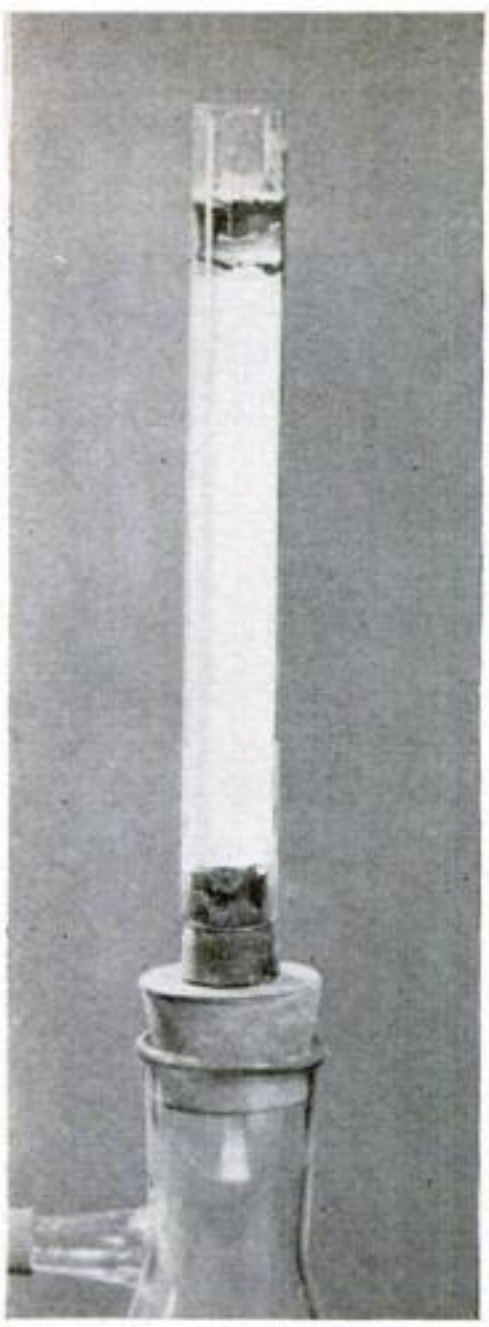
## Simple Method Makes "Spectrum" of a Complex Mixture

BY MEANS of bands of color, adsorbed by columns of alumina, magnesia, precipitated chalk, or even powdered sugar, chemists can now readily separate the constituents of complex chemical mixtures that not long ago defied division. By the same simple technique they can also purify chemicals; determine the structure of molecules; concentrate such substances as vitamins, hormones, and pigments from extremely dilute solutions; identify and compare drugs, dyes, and food products almost instantly. Although still employed chiefly as a tool in the research laboratory, experiments are being conducted to adapt the method to the isolation, purification, and testing of materials in the chemical and drug industries.

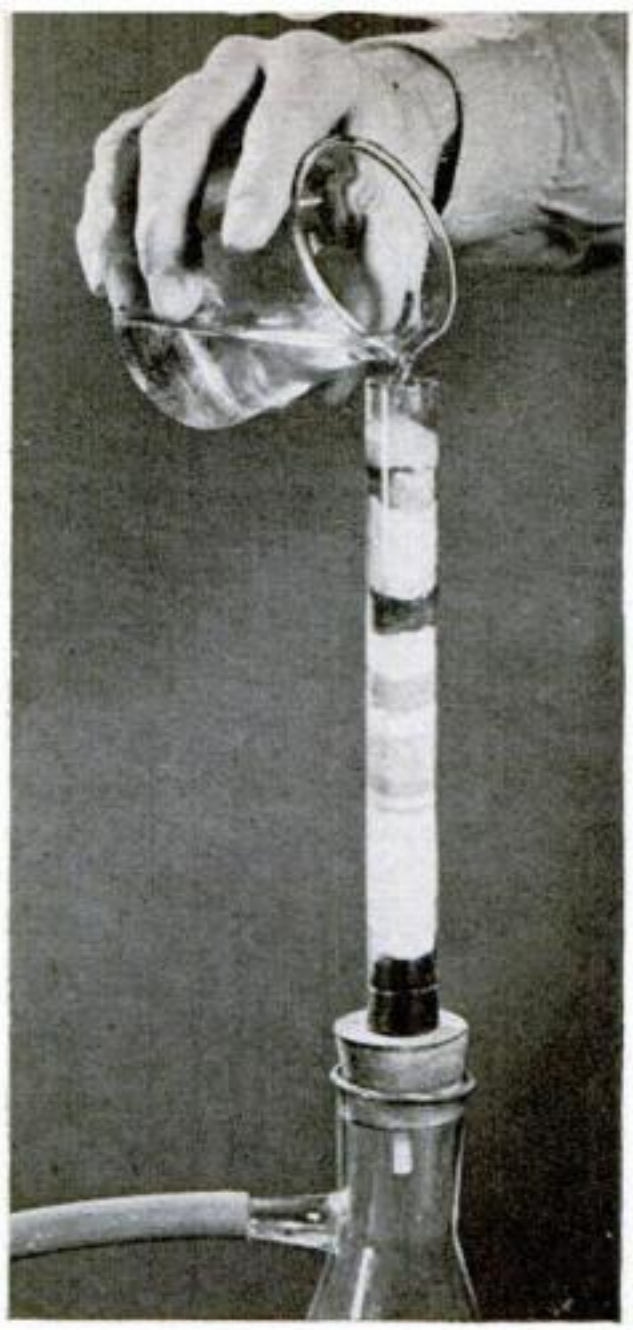
This "new" technique, named chromatographic-adsorption analysis by the inventor, was first developed back in 1906 by the Russian botanist M. Tswett, who was investigating the pigments in plant leaves. In his pioneer experiment, duplicated in principle in the photographs above, a chemist's dream was realized: the ingredients of a complex mixture were spread out for investigation like the colors of light in a spectrum. Still more amazing, they could be cut apart with a knife!

The reason for the separation of mixtures into distinct bands on an adsorption column is now considered to be this: molecules of different substances travel down a column of absorptive material at different rates, depending upon their individual affinity to the adsorbent. Substances that have a strong affinity for the adsorbent travel down slowly. Substances that have less affinity travel down faster.

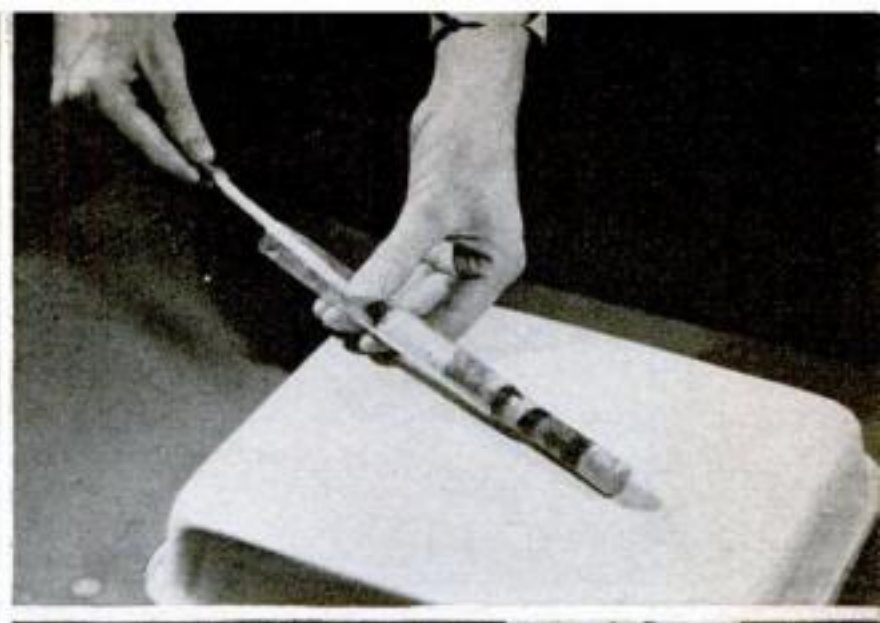
Tswett's simple but revolutionary method of chemical separation was little noticed for 25 years. In 1931 it came suddenly into

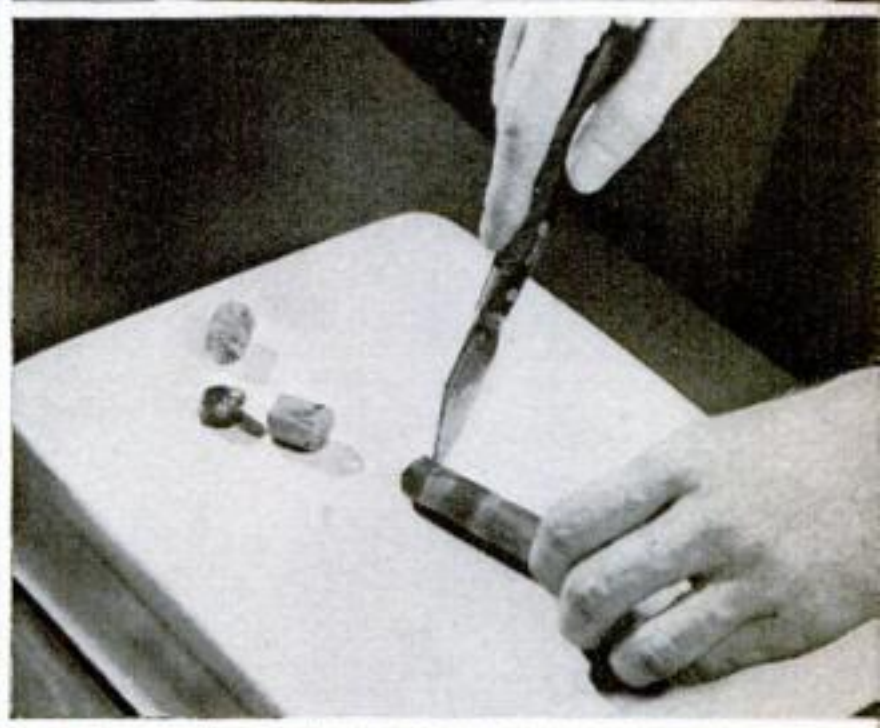


Solid pigments are held near the top of the column while the solvent flows through



To develop the chromatogram, clear solvent is poured in. This spreads out the color bands and separates them





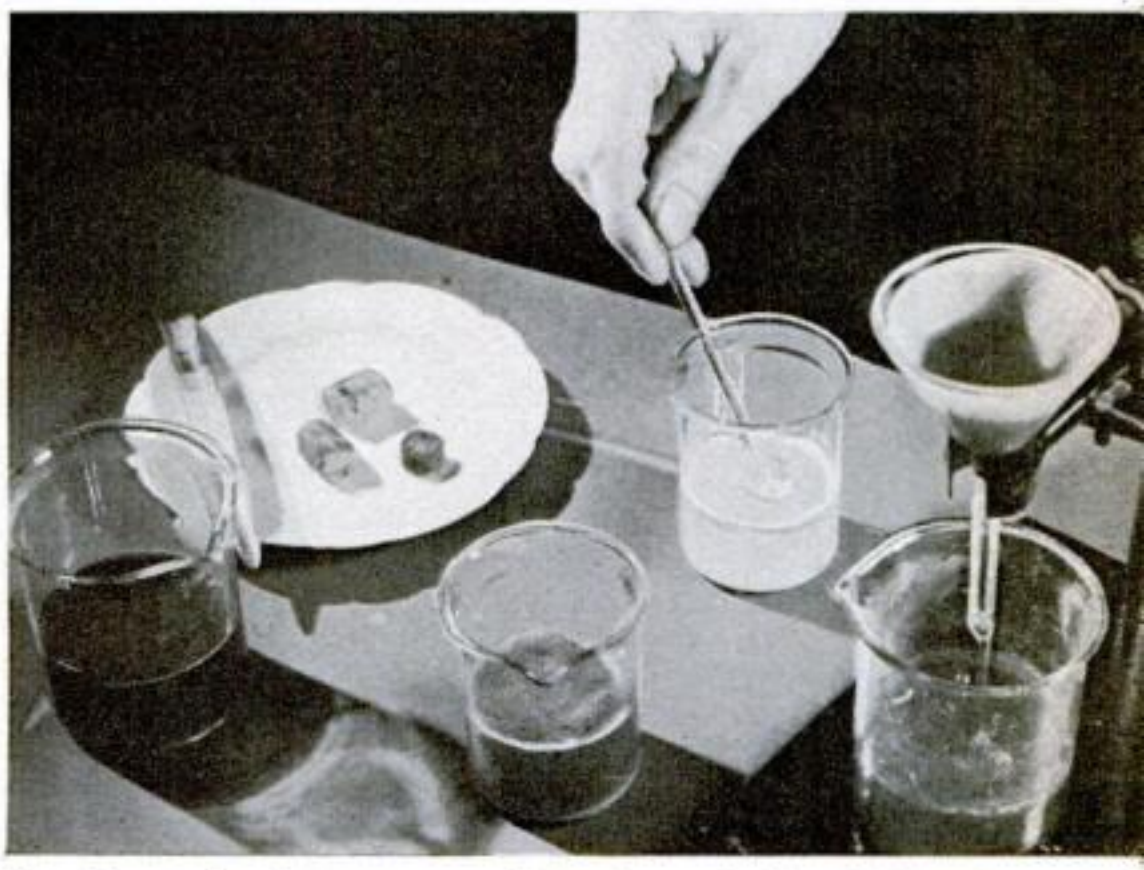
For further analysis, the core of adsorbent is partially dried and pushed out of the tube (at top). Then the various segments are cut apart carefully along the divisions of the color bands

prominence when Kuhn and Lederer passed carotene through an adsorption column and found that instead of being a single substance it was made up of a number of substances.

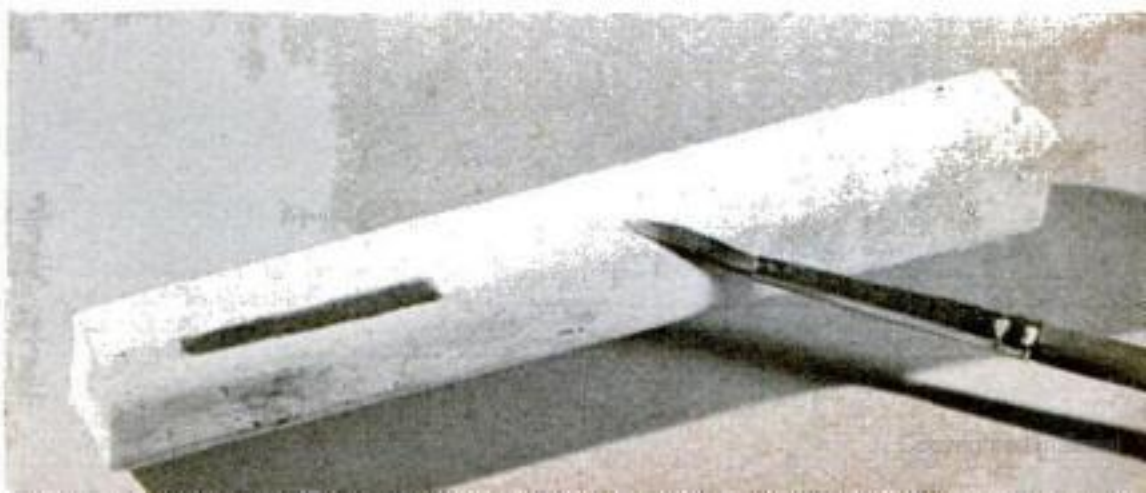
From the separation of plant pigments, it was only a step to the isolation and purification of vitamins. Some of the first pure specimens of Vitamin A, for instance, were made by chromatography. Vitamins D, E, K, $B_1$, $B_2$, and C were separated and purified by this method.

Means were soon found to isolate bands of chemical substances that were colorless or very faintly colored. By using quartz tubes in place of glass, and viewing the column by ultraviolet light, many ordinarily colorless chemicals were found to fluoresce with different colors.

Colorless Vitamin $D_3$ was isolated from fish-liver oils by means of an indicating pigment. Vitamin A, in a column, was detected by painting a streak down the column with the Carr-Price reagent, which turns dark blue in the presence of the vitamin.



The chemical substance in each band is washed and filtered out of the adsorbent. Colorless bands on an adsorption column often can be made visible by fluorescence under ultraviolet light, or by painting with a reagent as below




BY A curious coincidence, sunshine reaching us nowadays had its start when man first walked the earth, about a million years ago. And it has taken him all this time to figure out what produces the life-giving rays of heat and light.

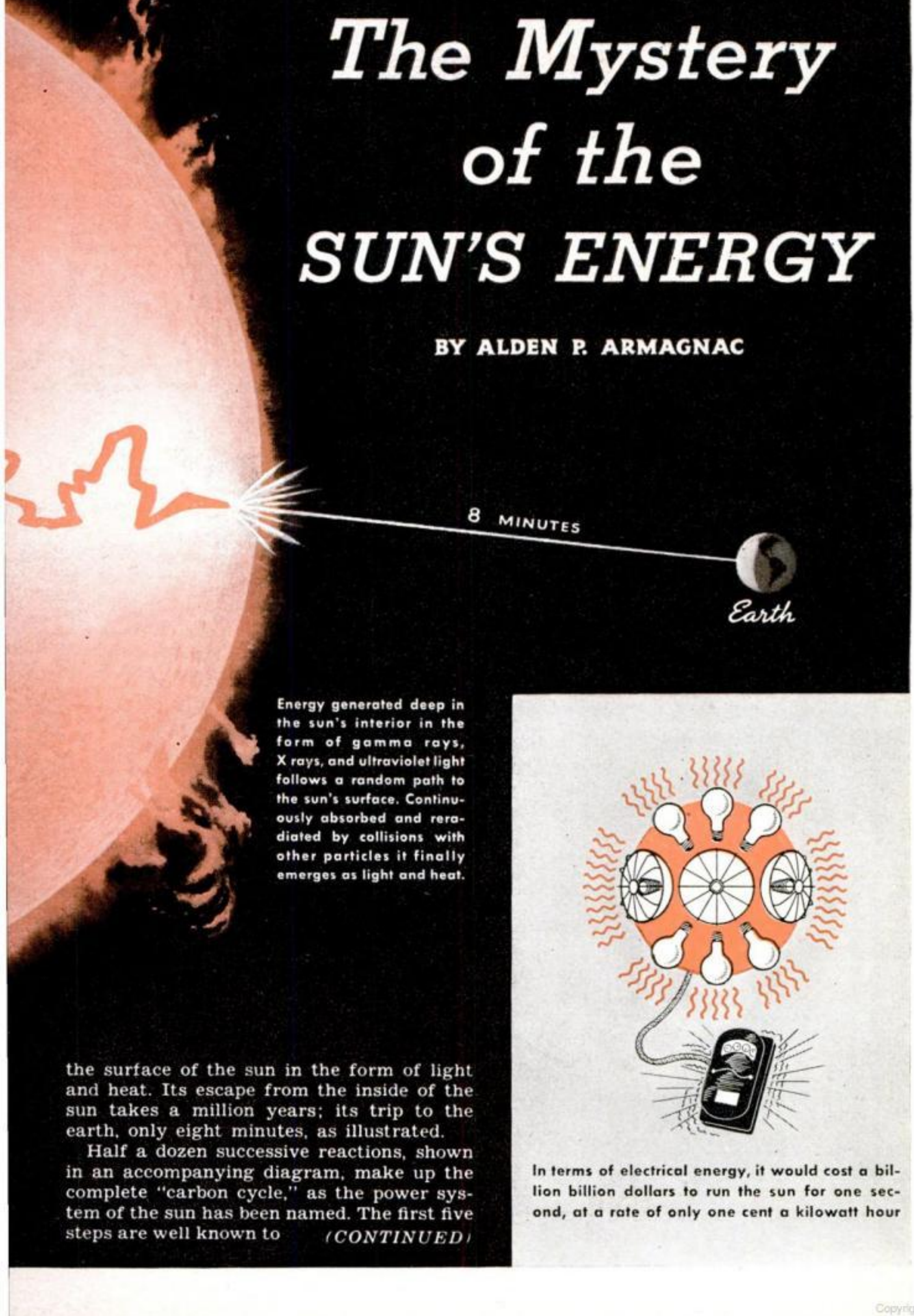
Deep in the interior of the blazing sun, a series of transmutations of the elements constitutes the machinery of the Solar Light and Power Company, according to Dr. H. A. Bethe, professor of physics at Cornell University. Hydrogen serves as the fuel. Helium represents the ashes. And carbon plays the part of a catalyst, or chemical go-between.

Each of the transformations emits a burst of short-wave radiation. This energy, bumping its way among countless particles that absorb and reradiate it, eventually reaches

ATOM SMASHERS SOLVE

# *The Mystery of the SUN'S ENERGY*

BY ALDEN P. ARMAGNAC



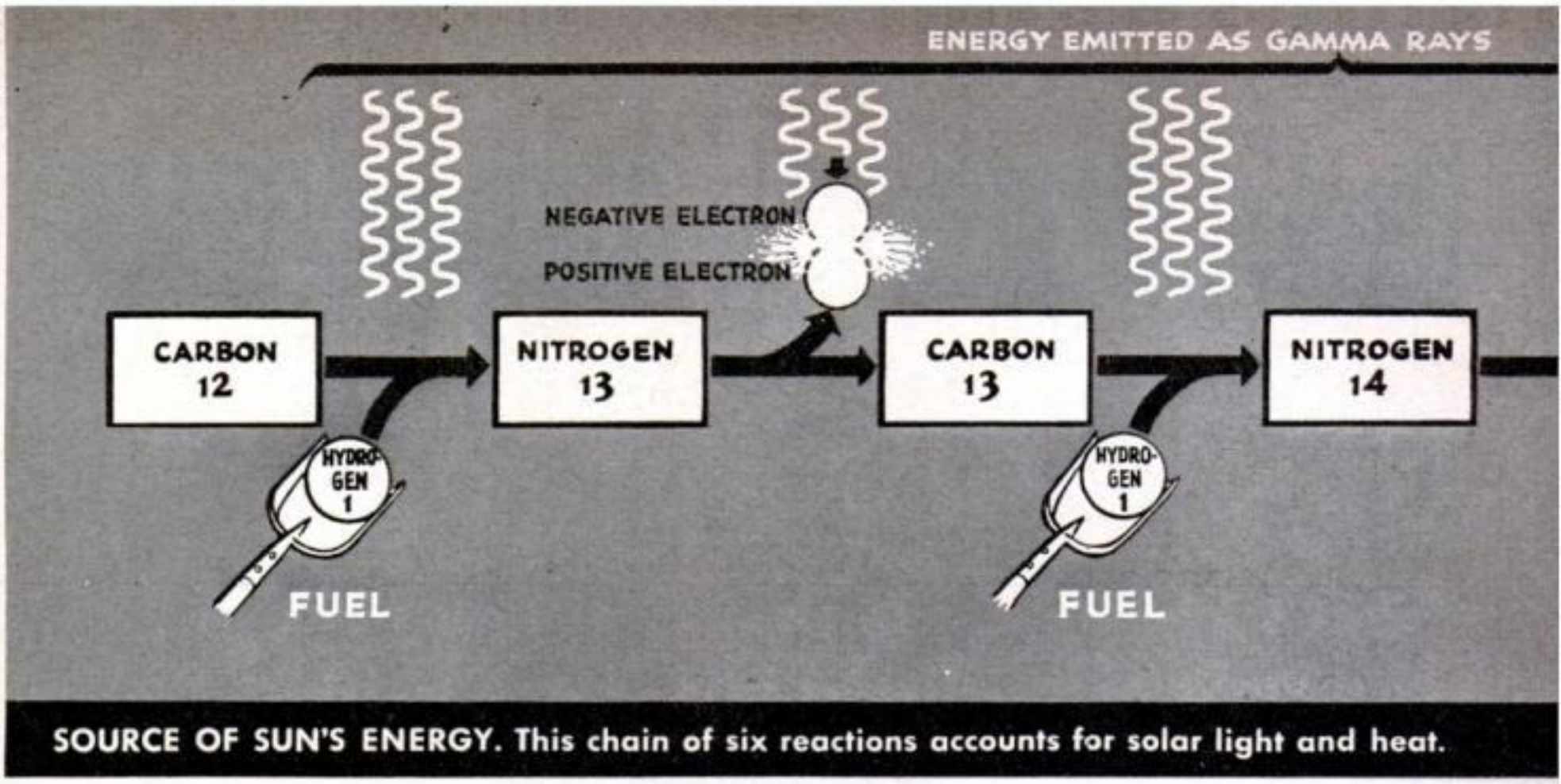

Energy generated deep in the sun's interior in the form of gamma rays, X rays, and ultraviolet light follows a random path to the sun's surface. Continuously absorbed and reradiated by collisions with other particles it finally emerges as light and heat.

the surface of the sun in the form of light and heat. Its escape from the inside of the sun takes a million years; its trip to the earth, only eight minutes, as illustrated.

Half a dozen successive reactions, shown in an accompanying diagram, make up the complete "carbon cycle," as the power system of the sun has been named. The first five steps are well known to *(CONTINUED)*



In terms of electrical energy, it would cost a billion billion dollars to run the sun for one second, at a rate of only one cent a kilowatt hour




**SOURCE OF SUN'S ENERGY. This chain of six reactions accounts for solar light and heat.**

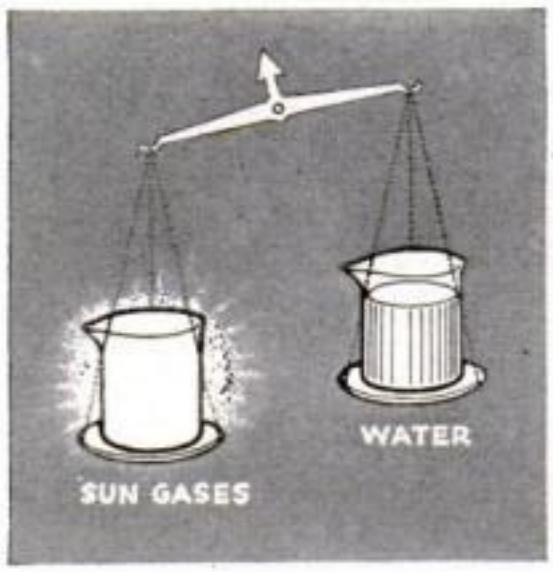
physicists, who have duplicated them on earth with high-voltage atom smashers. One of these tools, the three-ton cyclotron at Cornell University, now has enabled Dr. Bethe himself to discover the all-important sixth and final step, after which the cycle repeats itself. This has been going on for all the 1,500,000,000 years during which the sun has showered energy upon the earth. Comparison with earlier theories appears to clinch the new one as the true explanation for such a staggering output of power.

Suppose, as primitive man must have done, that the sun was literally on fire. If it were made of coal, burning in oxygen as in a furnace, its fuel would have been exhausted in 3,000 years—and the earth would be a mighty chilly place today.

More recently, astronomers have looked into a theory based on gravitation. Like a boulder falling from a high cliff, wouldn't the sun release energy if it were constantly shrinking? It would, and more than by burning—but when the amount of energy was calculated, it fell far short of the sun's vast store.

How about radioactivity, then? There's a word to conjure with. And if the sun consisted entirely of uranium, the parent element of radium, there need be no puzzling over its power supply. Unfortunately for this theory, observations with spectroscopes show other chemical elements to be abundant in the sun, while its actual content of uranium is estimated at a mere 1/1,000 of one percent.

And there astronomers remained stumped,

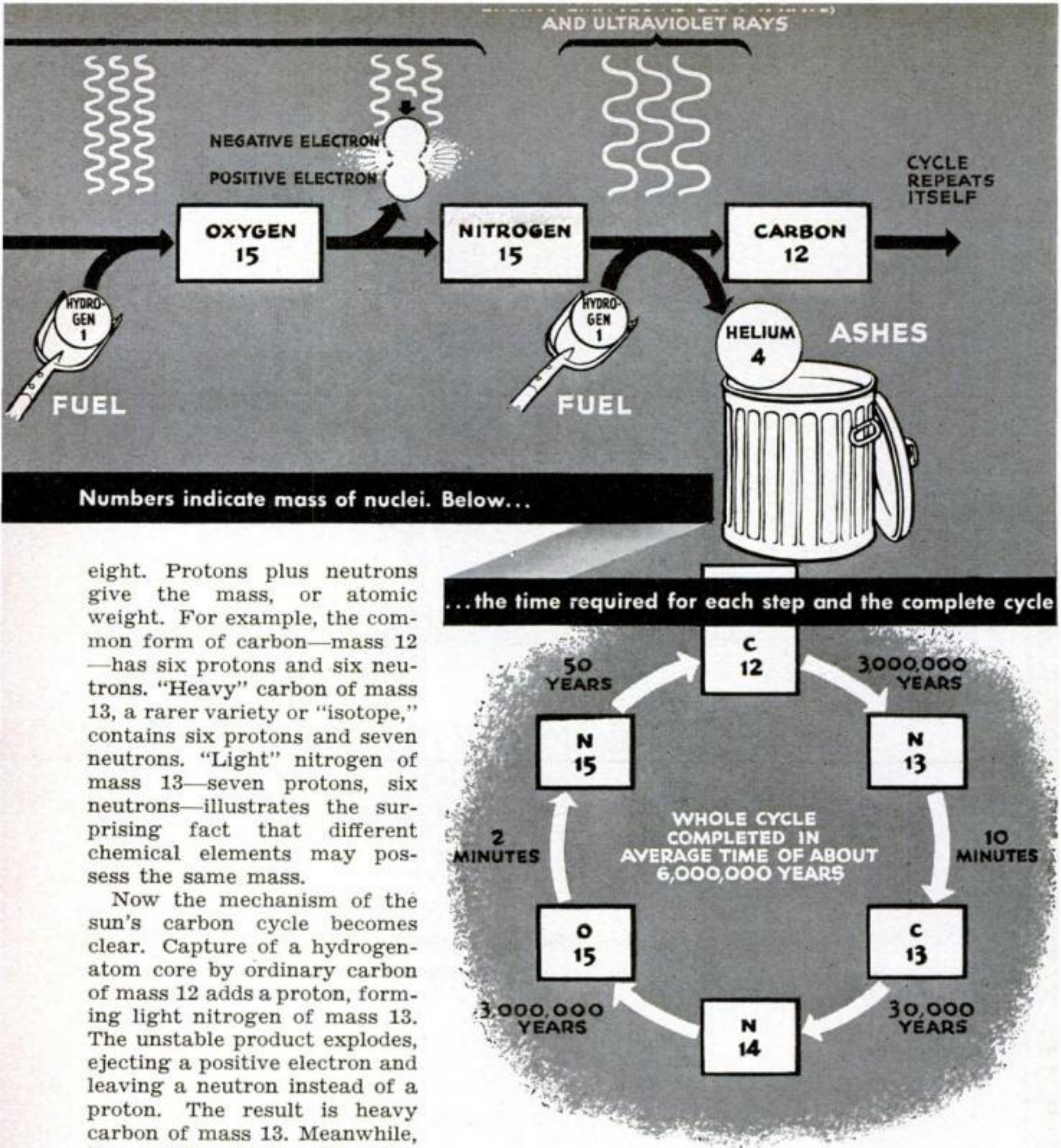



**GASES OUTWEIGH WATER.** Though the density of the sun is about 1½ times that of water, it is believed to be all gaseous

until Dr. Bethe and his fellow atom smashers came to their aid. For the known rate at which the sun produces energy—reaching us at about one horsepower per square yard of the earth's surface during daylight,—can be accounted for exactly by the carbon cycle. In all likelihood, just the same process explains the radiance of myriads of other stars similar in composition to the sun.

If the diagram of the carbon cycle, above, seems strange to students of everyday chemistry, there need be little wonder. Familiar interactions between molecules could hardly be expected in the sun, where gases weigh half again as much as water, and are heated to a temperature as high as 36,000,000 degrees Fahrenheit! Here molecules break down into atoms; the atoms themselves are stripped of their planetary electrons, which wander freely in space; and only the bare cores or nuclei of atoms remain to react with each other. Constantly colliding, they join or explode to yield new elements. A side glance at recent advances in atomic physics will help to understand how and why.

Simplest of all, a hydrogen-atom nucleus is nothing but a single proton—a composite particle made up of a neutron, a neutral part almost wholly responsible for its weight; and a positive electron, or positron. Cores of more complicated atoms contain both protons and plain neutrons, in various numbers. What the element will be depends solely upon the number of protons. Hydrogen always has one; helium, two; carbon, six; nitrogen, seven; and oxygen,




Once in 6,000,000 years, every carbon atom in the sun goes through the series of reactions diagrammed at the top of the page. This timetable shows the average interval between reactions

eight. Protons plus neutrons give the mass, or atomic weight. For example, the common form of carbon—mass 12—has six protons and six neutrons. "Heavy" carbon of mass 13, a rarer variety or "isotope," contains six protons and seven neutrons. "Light" nitrogen of mass 13—seven protons, six neutrons—illustrates the surprising fact that different chemical elements may possess the same mass.

Now the mechanism of the sun's carbon cycle becomes clear. Capture of a hydrogen-atom core by ordinary carbon of mass 12 adds a proton, forming light nitrogen of mass 13. The unstable product explodes, ejecting a positive electron and leaving a neutron instead of a proton. The result is heavy carbon of mass 13. Meanwhile, the positive electron blunders into a stray negative electron, and both vanish in a puff of energy.

Similar reactions produce, in turn, ordinary nitrogen of mass 14; light oxygen of mass 15; and heavy nitrogen of mass 15. Finally, as shown by Dr. Bethe, addition of a hydrogen nucleus yields ordinary helium of mass 4 and carbon of mass 12. The net result is that four hydrogen nuclei have been consumed, one of helium has been created, the carbon reappears in its original form—and the sun shines on. It will continue to do so, according to calculations based on the new theory, for the satisfying figure of 30,000,000,000 years.

Before settling upon the explanation above, Dr. Bethe weighed other possible atomic reactions. In the long run, laws of probability predict their likelihood just as surely as a throw of dice, or the normal expectancy of life at birth. Conceivably, four hydrogen-atom cores might unite directly to form one of helium. But the mathematical chance of the event is so remote that it probably has never once happened in the entire history of the sun! Elimination of other unlikely reactions appears to leave the carbon cycle as the one and only theory that fits the facts.

# America's

Ten high-flotation rubber tires on high-speed axles carry the crushing weight of this American-designed 155-mm. long rifle across rough terrain. Compare it with the guns of the past!

**ARTILLERY is the means of transporting destructive force for use in war; it carries fire power to the point where it can do most harm to the enemy. In today's blitzkrieg warfare of swift movement, mobility becomes the first consideration. Mobility means high-speed axles, and America's automotive experience has given us the best high-speed axles in the world. Our artillery might is a devastating thing because ingenuity has placed guns of terrific power at the disposal of every combat soldier.**

**By CARL DREHER**

WE HAVE been hearing so much of planes and tanks that the artillery arm has been shoved into the publicity background. Just the same, artillery remains very much in the forefront of practical military thinking, and there is no sign that it will diminish in importance as planes fly faster and tanks get bigger. For that matter, what is a bomber but a piece of flying artillery, with gasoline and gravity propelling the projectile instead of gunpowder? And when you mount a cannon on a pair of caterpillar treads and surround it with armor and a few machine guns for close-up protection, isn't it still a cannon?

For the present purpose, however, we need not take in that much ground. Limiting the argument to artillery in the conventional sense, let us consider the composition of a typical German armored division. Its chief striking power, of course, comes from its tanks. But behind the tanks one always finds a regiment of motorized artillery, equipped with 105-mm. pieces, and 150-mm. as well. (25.4 mm. = 1 inch.) Likewise an antiaircraft-antitank battalion with 20-mm., 37-mm., and 47-mm. guns, usually on self-propelled armored mounts. Artillery protects the tanks during the assembly period—nothing is quite as vulnerable as a parked tank, unless it is an airplane on the ground. During the attack an artillery

# Artillery Might

liaison officer rides in a tank in close proximity to the tank battalion or regimental commander. When anything untoward happens, such as the sudden discovery of an antitank battery in a tankproof area where it can fire on the flanks of the advancing column, there is an immediate call for the artillery to silence the AT guns from a safe distance. Clearly, as far as the redoubtable Nazi *panzers* are concerned, artillery is far from an outdated arm.

For holding ground, and for a great deal of ground-gaining, the Germans, like other nations, still rely largely on infantry. What then is the relation of artillery to infantry in this, still the most successful of European armies in spite of its recent reverses? "In the German Army," writes one of their colonels, "it is fundamental that no infantry attack is to be carried out without artillery support." A German infantry regiment is equipped with 12 AT guns, 27 two-inch mortars, 18 three-inch mortars, six 2.95-inch guns, and two 5.9-inch guns. The divisional artillery is equipped with 36 105-mm. howitzers, 12 150-mm. howitzers, and other large pieces. Artillery observers stick close to the infantry commander, maintaining contact with their batteries by radio and supplying help promptly wherever needed.

Our own Army has studied the lessons of the European campaigns very carefully and here is the result as far as artillery is concerned: The square infantry division (four regiments) is supported by a field-artillery brigade of three regiments which carries 48 105-mm. howitzers and 24 155-mm. howitzers. The triangular infantry division (three regiments) has proportionate numbers of the same weapons. The armored division supports its 390 tanks with 57 60-mm. mortars and 27 81-mm. mortars, as well as 194 37-mm. towed AT guns; 42 75-mm. and 54 105-mm. howitzers, all self-propelled. Obviously our general staff relies on artillery to a considerable extent to win the war, and it is scarcely likely that American artillerymen will have any reason to complain that they are in a branch of the service where a man has no chance to show his mettle.

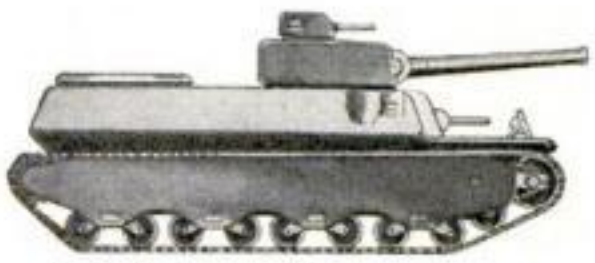
All the weapons thus far mentioned were used in World War I. That is, the calibers and classifications were the same. But when we examine the individual pieces in

THEY'RE ALL ARTILLERY! Gone are the days when a cannon could be defined as a big gun barrel on two wheels. Today, it may be man-carried, like the 81-mm. mortar; it may be towed by a high-speed prime-moving truck; on a self-propelled tank-type mount it may roll across the battlefield, or it may ride the air in a plane. A tank gives it a mobile turret and armor protection for its crew. And, it may be permanently mounted for coast or antiaircraft defense

Three men carry the 81-mm. mortar

Planes also transport fire power

Towing is done by high-speed trucks



A tank is a rolling gun turret

This gun has a self-propelled mount

Harbor defense (permanent emplacement)

MAN-CARRIED ARTILLERY is represented here by the 81-mm. mortar. Adapted from a French idea, it provides accurate fire for troops afoot where wheeled equipment cannot go. In the last war we used the Stokes mortar, a rudimentary weapon that delivered a fairly effective fire. Now the infantry mortar has come of age. With the accurate artillery sight, men say they can hit a bathtub at 1,000 yards

more detail, we find a great improvement in fire power, mobility, and accuracy. The rate of progress is not as striking as in the case of the airplane, but then the airplane is not yet 50 years old, while cannon date back to the thirteenth century.

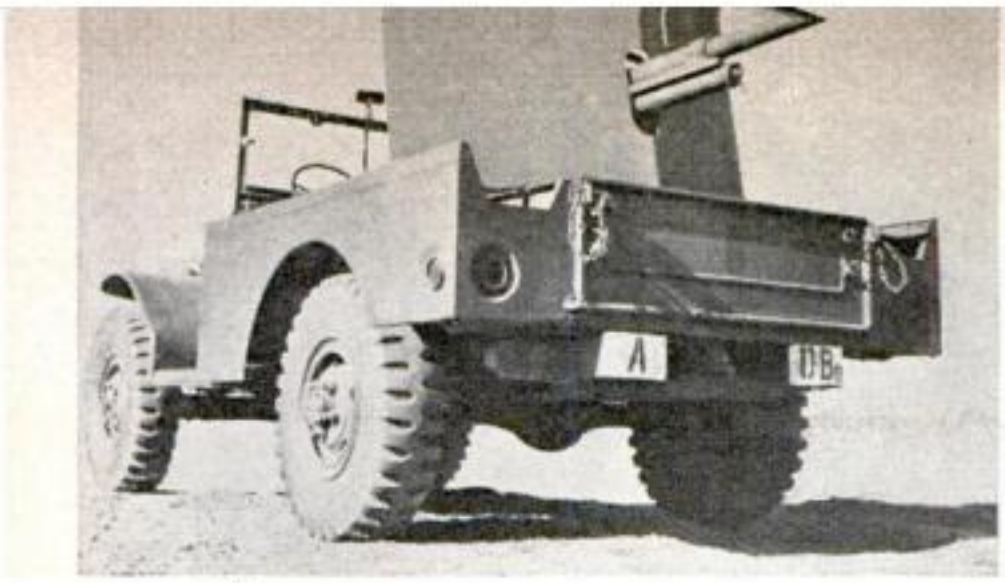
The humble but invaluable trench mortar is a good example of the advances made in the last 20 years. A mortar is simply a light steel tube set on the ground pointing skyward, and supported in front on two legs, forming a tripod. Usually it is muzzle-loaded: the shell is dropped into the tube, the propellant charge in the base of the shell is exploded by a firing pin, and the projectile sails out considerably faster than it went in. But not very fast as shellfire goes—if a modern pursuit plane took off from the muzzle at its normal speed just ahead of the shell, the latter would not quite catch it. The trajectory of the mortar projectile is like a lob

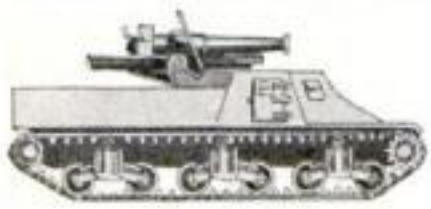
TOWED ARTILLERY comes closest to the traditional picture of lumbering caissons and straining horses. But now the wheels roll on high-flotation rubber tires and the horses are under the hoods of fast trucks. Guns up to almost ten-inch bore move this way

Standardization of parts is a weapon in itself. Above is the new 155-mm. howitzer with a high-speed mount. In the picture below, the same mount is adapted to the new 4.5-inch gun, more powerful than the 105-mm.



Largest of our mobile guns is the 240-mm. howitzer (right), now redesigned for transportation in two sections on paved roads. Previously, it would tear up any highway





SELF-PROPELLED guns are unexcelled as tank destroyers and as threats to ground troops, because of their mobility. Above is a 37-mm. fully shielded on a ¾-ton truck of low silhouette. When menaced, it can move at tremendous speed to a new location. Drawing is our artist's conception of a 155-mm. howitzer on a tank's chassis

in tennis, high and slow, and, like the lob, it can be extremely annoying when well placed.

The familiar Stokes mortar of the first World War proved that much, in spite of the fact that, being a smoothbore weapon, it had no means of preventing the projectile from tumbling end over end on its course. This not only increased the drag and shortened the range, but, since no two projectiles tumbled in the same way, dispersal of shots was great. The modern mortar fires an elongated, tear-shaped projectile equipped with tail fins to keep it pointed on its course. As a result of this and other improvements, it has become a much more formidable weapon. The following table shows how it compares with the World War I model:

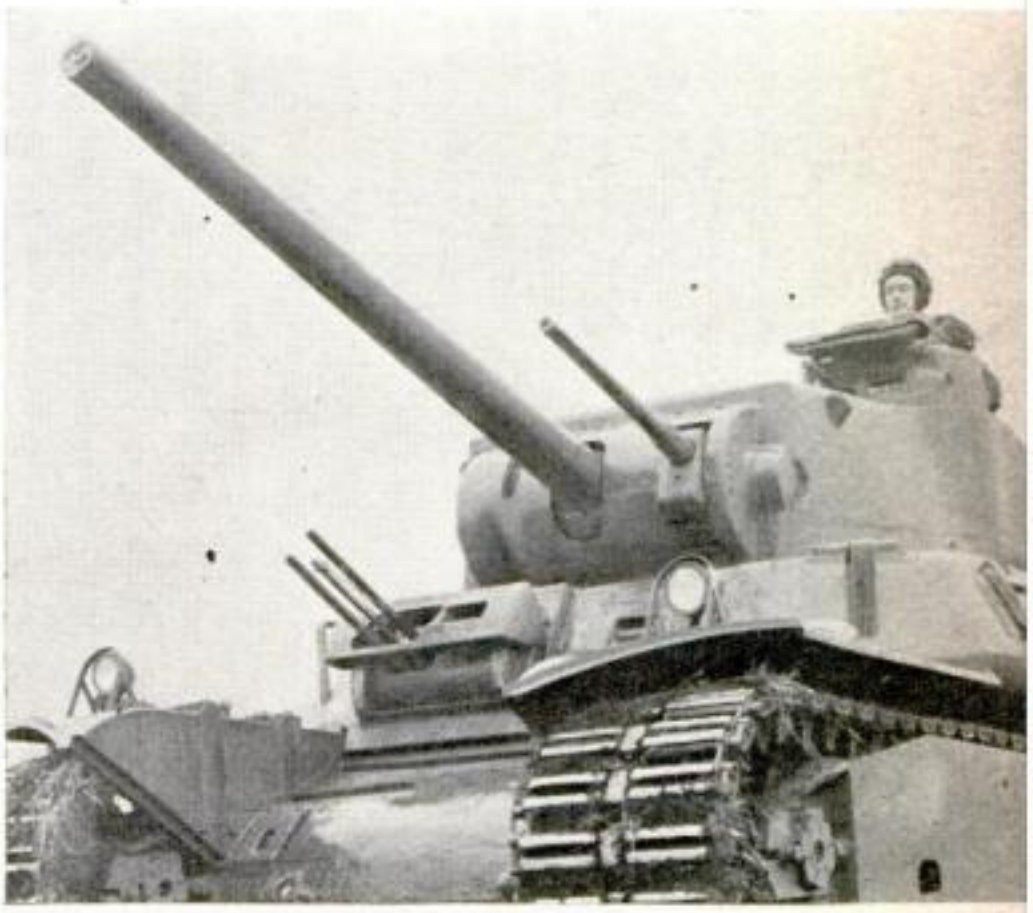
*Trench Mortars*

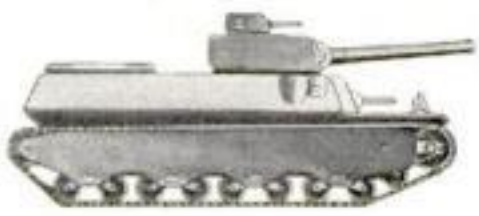
| | 3-in. Stokes | 60-mm. M-2 | 81-mm. M-1 (3.2 in.) |
|---|---|---|---|
| Weight of projectile, pounds | 12 | 3 | 6.9 and 15.01 |
| Maximum range, yds. | 750 | 1,935 | 3,290 and 1,275 |
| Weight of mortar in firing position, pounds | 110 | 42 | 136 |

Thus the modern 81-mm. mortar, with caliber slightly larger than the Stokes and firing a projectile 3.01 pounds heavier, has a range 70 per cent greater, and higher accuracy for a given range. At the same time the piece is only 26 pounds heavier. The smaller 60-mm. mortar, with a range of over a mile, weighs 42 pounds and can be carried by one man. With all the other developments simultaneously taking place, one can never predict how important such improvements may prove to be in a modern war. A light cannon is just what the doctor ordered for air artillery. Each German parachute battalion is liberally equipped with 75-mm. guns, 81-mm. mortars, or mine-throwers, as the Germans call them, and an abundance of 50-mm. mine throwers. This is in addition to each parachutist's

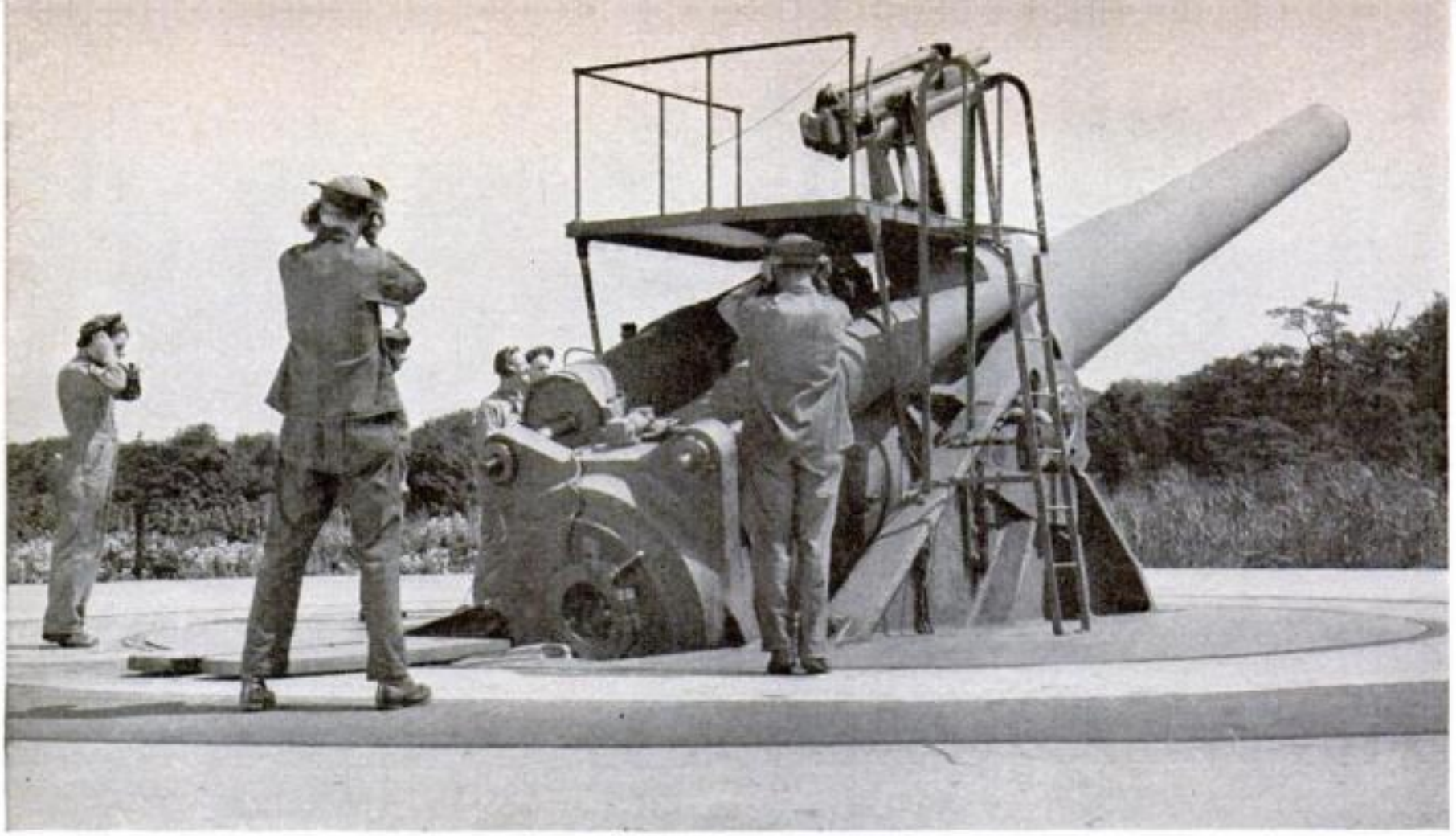


AIR-BORNE ARTILLERY. The warplane is itself an artillery piece; unarmed it is useless. Unlimited in its attack by obstacles of terrain, it can destroy enemy planes, pound ground objectives. Ever the trend is toward larger guns—.30 and .50 caliber machine guns, cannon up to 50-mm.





TANKS are nothing more than fast self-propelled gun mounts with armor protection. As mobile artillery pieces, they are the most effective ground weapons man has devised. Two years ago, America had no tank worthy of the name; today, our tanks have better engines, higher ricochet value, and higher speed than any built by our allies or enemies



FIXED GUNS are useful for coast protection and also for antiaircraft defense. Fixed antiaircraft guns run from three to nearly five-inch caliber, and the larger ones can shoot a bomber out of the substratosphere. The gun above is a 12-inch coast-artillery rifle for use against enemy ships far at sea

personal armament of automatic pistol, hand grenades, and dynamite sticks.

The larger cannon classed as field artillery likewise reflect the results of research in ballistics, gun manufacture, the chemistry of explosives, and all the other technical arts that go into armament production. Field pieces are divided into guns and howitzers, the latter being distinguished by their short barrels and higher elevation. For a given caliber the gun will have a longer barrel, higher muzzle velocity, and, as a rule, longer range. The distinction between the two types is becoming less sharp as gun elevations increase, while at the same time howitzers are acquiring higher muzzle velocities and longer ranges. One consequence is that the 105-mm. howitzer is now largely replacing the 75-mm. gun in our Army, in spite of great improvements in the latter. A 75-mm. gun of 1918 design was limited to a six-degree traverse or side-to-side swing without shifting the trail. By means of a split-trail arrangement the traverse has been increased to 85 degrees, or almost a right angle, and the maximum elevation has gone up from 19 to 45 degrees. Partly through the higher elevation, the range has been increased from 9,700 to a maximum of about 13,000 yards, and mobility has been greatly improved by mounting the piece on a high-speed carriage. But the 105-mm. howitzer is practically as mobile; it weighs 4,300 pounds—only 500 pounds more than the 75-mm. gun, and can be towed by a 2½-ton truck. Firing on its own wheels, it is practically ready for action when it stops rolling. It has about the same range as the 75-mm. gun, but the big advantage of the howitzer is that it throws a 33-pound projectile instead of the 15-pound shell of the 75. A piece which can deposit twice as much TNT on the enemy per shot is obviously to be preferred, and that is why the 105-mm. howitzer is getting a bigger share of the business in the present war.

For more oomph, the artillery goes up to the 155's. The howitzer weighs only 9,000 pounds and, equipped with air brakes and pneumatic tires, can be drawn by a truck at 50 m.p.h. on a good road. Once it gets there it can be emplaced in a few minutes. The 155-mm. howitzer fires a 95-pound shell, as does the gun of the same caliber. The gun has double the range—25,000 yards as compared with 12,400 for the howitzer. This gun is really a heavy piece—15 tons—and it requires a truck or tractor of about the same weight to move it. Beyond the

## ARTILLERYMEN AS FRONT-LINE FIGHTERS

In the fluid warfare of today, the artilleryman frequently finds himself in the first combat line alongside the rifleman, the tanker, and the pioneer. For close-up fire, both American and foreign troops are reverting to the use of canister, projectiles that disintegrate on leaving the gun muzzle and scatter pellets in a shotgun pattern. Old types of canister are illustrated

CARBINE (.30 CAL.)

155-MM. HOWITZER

75-MM. HOWITZER

AUTOMATIC RIFLE WITH BIPOD (.30 CAL.)

GARAND RIFLE

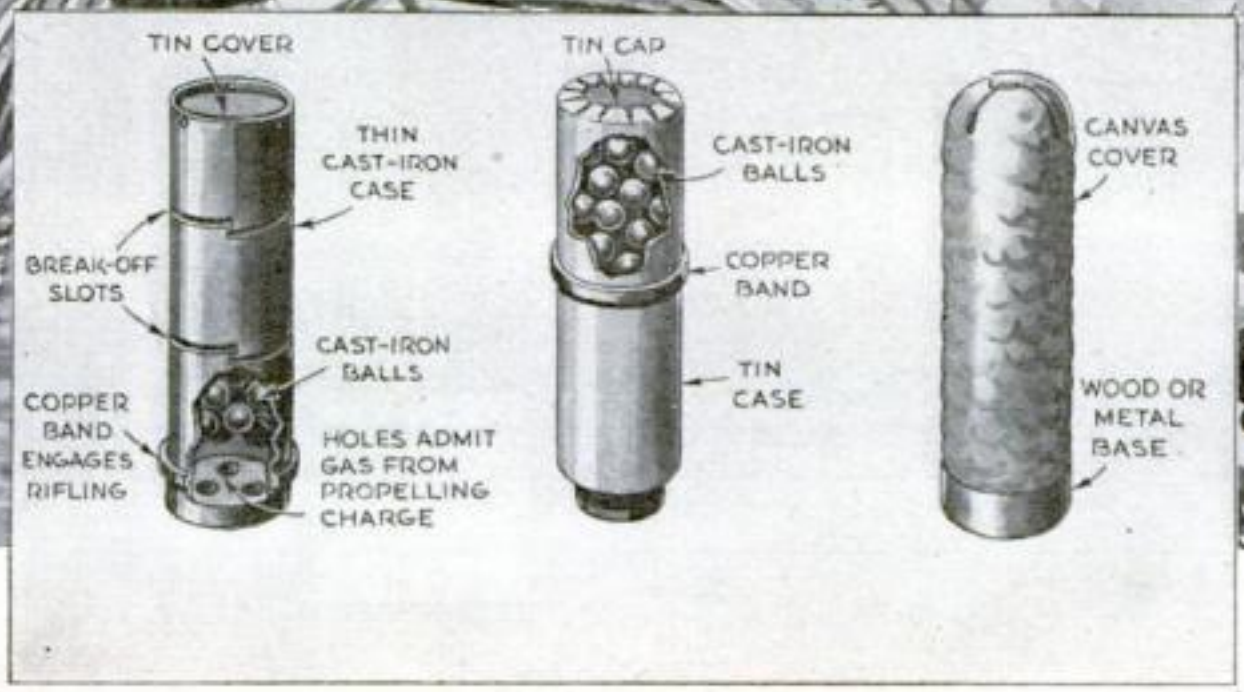
75-MM. GUN

MACHINE GUNS (.30 CAL. AND .50 CAL.)

37-MM. GUN

SUBMACHINE GUN .45 CAL.

MORTARS (81-MM. AND 60-MM.



155's we get into the really big field artillery, like the 8-inch and 240-mm. calibers, some mounted as railroad guns.

One might imagine that guns weighing 10, 20, and 40 tons with their tractors, and necessarily presenting problems when it comes to crossing bridges, traversing underpasses, traveling on two-lane roads, etc., would have been superseded by the bomber by this time. But once a big gun has been strategically sited and has got the range it can pound a target with an accuracy far exceeding that of the best bombers. As a siege weapon against cities and fortifications it still has no equal. It can make a vital enemy position absolutely untenable and do terrible damage to any body of troops which tries to stand up against it without equivalent fire power.

The allocation of artillery to bodies of troops is something like a banking system. The smallest pieces are part of the organic equipment of platoons and companies of infantry. The 105 is a divisional arm, the 155 both division and corps. Bigger guns are assigned by GHQ as required. GHQ would correspond to the Federal Reserve, the small infantry units to the country banks; in between there are the metropolitan banks with their larger resources. Any group may requisition or borrow artillery from a higher echelon—if it can get it. As in the money market during a financial crisis, the would-be borrower does not always find a willing lender.

The advances in field artillery, notable as they are, have been overshadowed by advances in antitank and antiaircraft guns. This was a matter of military necessity. Every weapon has its counterweapon, and the development of one compels the development of the other. In the first World War it was found that the machine gun had made the defense too strong. Infantry could no longer advance except at fearful cost. The tank was evolved to cope with the machine gun. The antitank gun was then pitted against the tank.

Actually the surest defense against the tank is another tank, preferably a bigger one. But an antitank gun costs only about a tenth as much, in manpower and materials expended in manufacture, and thus fills a definite need. Since it often accompanies infantry it must be as light and small as possible. The effective range need not exceed 1,200 yards, but the trajectory must be flat so that tanks cannot roll underneath as they close in. A flat trajectory means high muzzle velocity and a relatively small shell.

The 37-mm. AT gun, which represents a good compromise between these requirements, is mounted *(Continued on page 210)*

## On These Weapons America Rests Her Hope of Victory

### MOBILE FIRE POWER

Grenade
Pistol
.45 cal. Submachine Gun
.30 cal. Semiautomatic Carbine
Rifle
Garand Rifle
.30 cal. Automatic Rifle
.30 cal. Light Machine Gun
.30 cal. Heavy Machine Gun
.50 cal. Machine Gun
37-mm. Antitank
37-mm. Self-Propelled
40-mm. Bofors
75-mm. Gun
75-mm. Howitzer
75-mm. Antitank (Self-Propelled)
105-mm. Howitzer
105-mm. Antitank (Self-Propelled)
4.5-in. Gun
155-mm. Howitzer
155-mm. Rifle
8-in. Howitzer
240-mm. Howitzer
8-in. Railway Gun
60-mm. Mortar
81-mm. Mortar
Land Mine
Sea Mine

### PLANE FIRE POWER

.30 cal. Machine Gun
.50 cal. Machine Gun
20-mm. Cannon
37-mm. Cannon
50-mm. Cannon

### TANK FIRE POWER

.30 cal. Machine Gun
.50 cal. Machine Gun
37-mm. Cannon
37-mm. Automatic Cannon
50-mm. Cannon
75-mm. Cannon

### ANTIAIRCRAFT

.30 cal. Machine Gun
.50 cal. Machine Gun
37-mm. Cannon
40-mm. Cannon
75-mm. Cannon
90-mm. Cannon
4.7-in. Cannon
.30 cal. Automatic Rifle

### COAST ARTILLERY

3-in. (Antitank, Antiaircraft, Harbor Defense)
6-in. Rapid-Fire
10-in. Gun
12-in. Gun
14-in. Gun
16-in. Gun
16-in. Howitzer

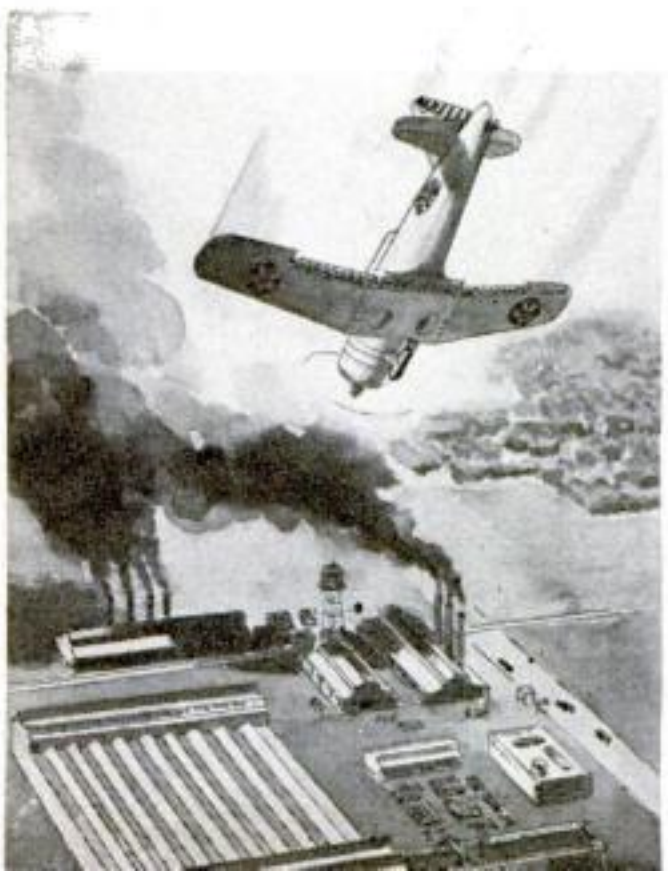
As a flying machine gun, the plane is superior to large numbers of guns on the ground because it can search out enemy troops anywhere with the factors of surprise and easy escape

With its 20, 37, or 50-mm. automatic cannon, a plane can attack armored positions on the ground, either fixed or mobile. Lightly armored on top, tanks are specially vulnerable from the air

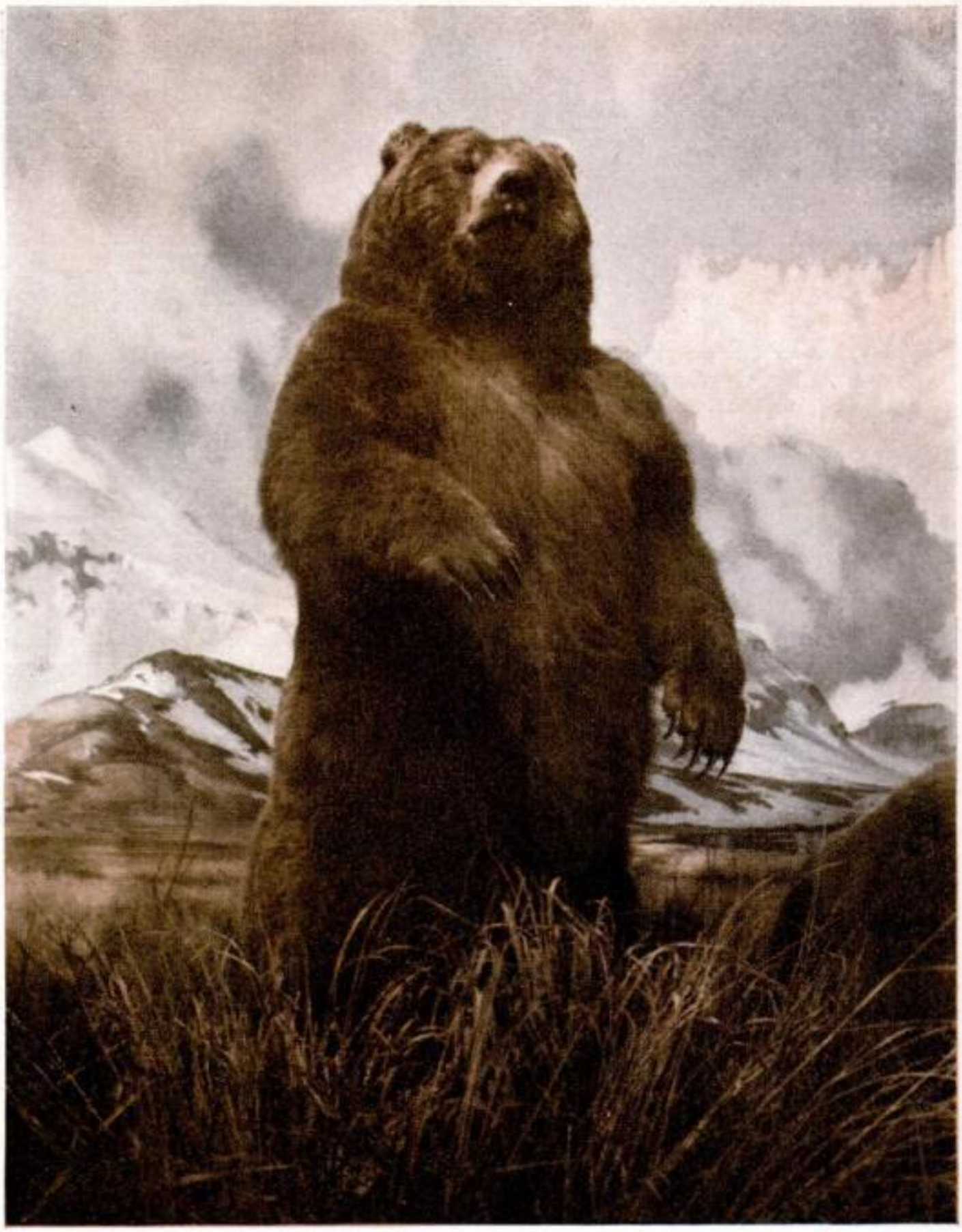
Here a hedge-hopping attack bomber lays the equivalent of a barrage of 75-mm. shells. Parachutes on bombs enable the plane to escape blasts

GUNS ON WINGS. For supporting ground operations, the airplane is one of the most effective artillery pieces ever devised. It has vastly higher maneuverability than any earthbound cannon, and it is less vulnerable to attack than other weapons. Planes are now being equipped with every type of destructive device that engineers can turn out, with larger bombs and heavier guns giving ever greater fire power. In the photograph below, British bombers are supporting a tank operation in the swiftly moving desert war

A high-flying heavy bomber carries the hitting power of a 16-inch gun. Above, dropping a six-ton stick. A dive bomber is a large-caliber cannon firing charges up to half a ton



# Recording America's



An Alaska brown bear, largest carnivorous land mammal, towers in a realistic setting in one of the 18 habitat groups of the new Hall of North American Mammals, American Museum of Natural History

THE world's largest and finest collection of North American mammals, including many species which are nearing Extinction, is being assembled at the American Museum of Natural History in New York. It will contain specimens obtained by field expeditions throughout the continent, from New York State to the west coast of Alaska and from Mexico to Ellesmere Island near the North Pole. Ten habitat groups, mounted in authentic and realistic settings of their native plains, mountains, swamp, and desert, have already been completed and placed on exhibition. Among the animals represented in these groups are the moose, the caribou, the bighorn sheep, the musk ox and the Alaska brown bear, which is the largest carnivorous land mammal in existence. Eight other groups will be ready in the near future.

Work on the project began in 1935 when Dr. James L. Clark, Director of Arts and Preparations for the Museum, constructed a miniature of the new Hall of North American Mammals. Built to a scale of two inches to the foot, this miniature showed each habitat group laid out exactly as Dr. Clark proposed to present it with the real specimens. Even the proposed backgrounds were painted in and the stones faithfully simulated.

After the plans had been approved, 18 ex-

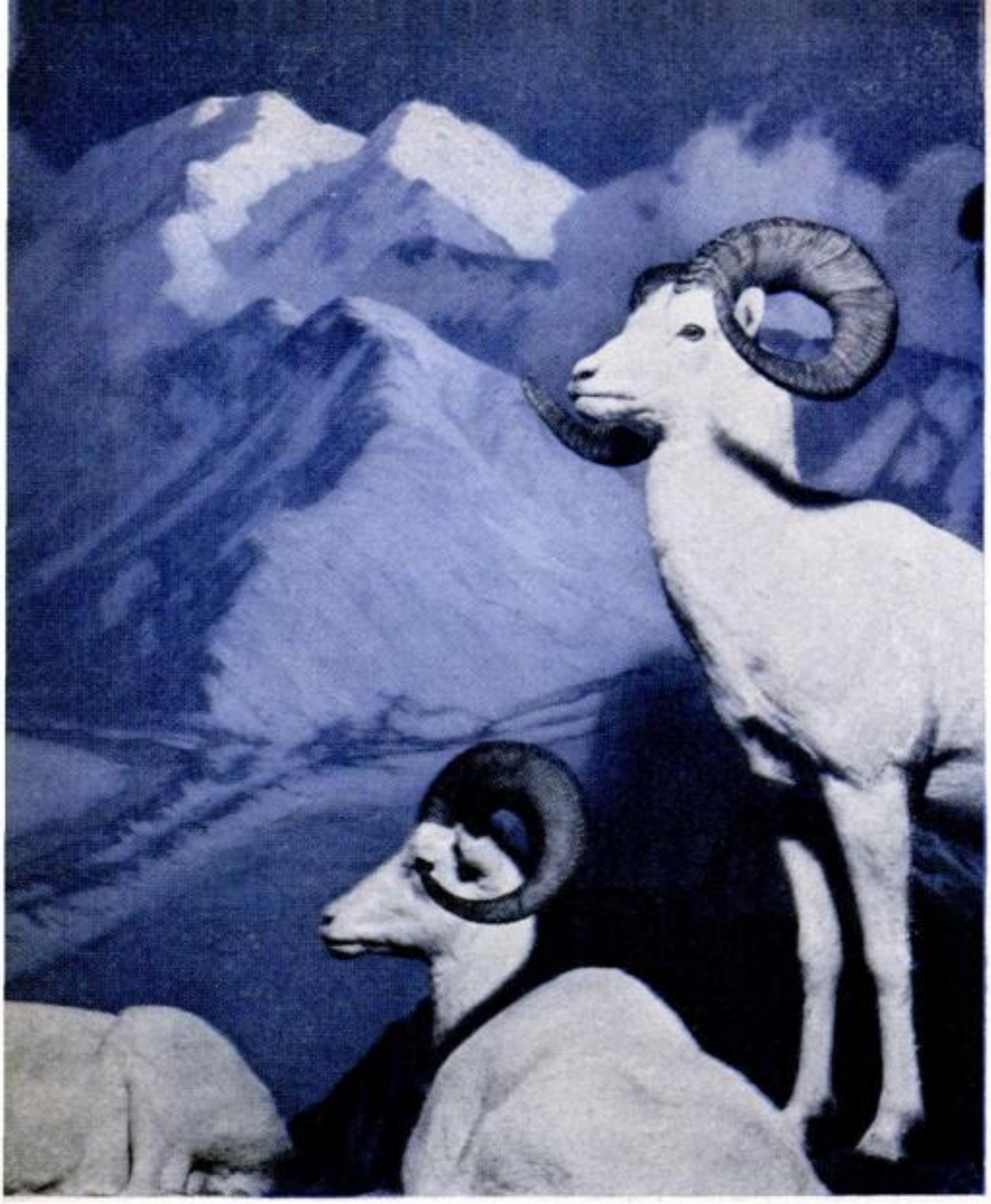
# Wildlife

PHOTOGRAPHS BY CHARLES COLES, AMERICAN MUSEUM OF NATURAL HISTORY

Using a special turned-edge knife, a museum expert "shaves" a skin brought in by a field expedition for mounting in one of the groups

Shaved skins are "tanned" in an alum-salt bath, partly dried, oiled, and drummed in fine hardwood sawdust in the cylinder seen at the right

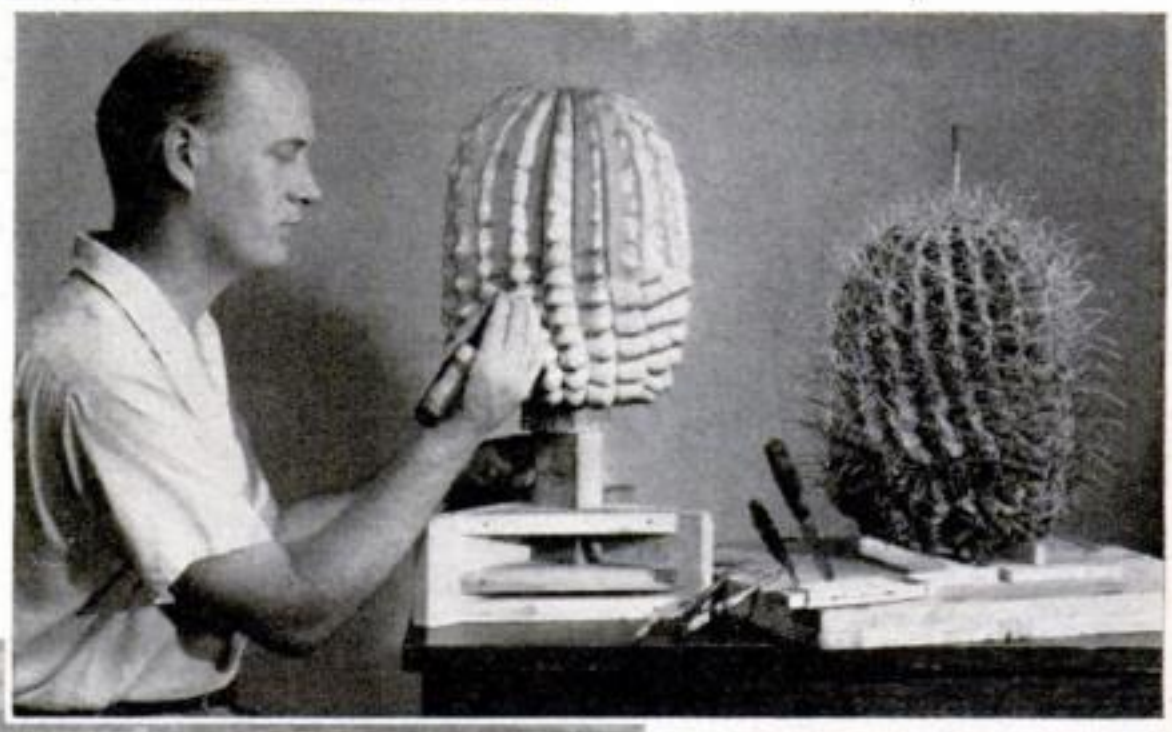
**Treatment with oil softens the skin for mounting. After drying, the finished skin is fitted carefully over a body made by modeling clay on the assembled skeleton and using this for preparing a mold with which papier-mâché is cast in the desired shape. A lifelike pose is thus obtained with every specimen**



peditions were sent into the field to procure the material. Artists and photographers collected pictorial material for backgrounds. Botanists made leaf molds of plants and trees. Stones and grasses were carefully shipped to the Museum to be artificially reproduced by skilled technicians. One expedition was instructed to bring back a bull moose which would fit into a case only eight feet in height. An animal of the exact dimensions required was shot, and was found to possess an antler spread of 77⅝ inches, a world's record. The expedition in search of bighorn sheep had similar good fortune, returning with a ram which had the world's record horns. The curve of this animal's right horn measures 49½ inches in length.

Groups that are nearly completed include those of bison, wapiti, Virginia deer, elk, and jaguar.

Bighorn sheep sniff the air against a background representing a setting in Jasper National Park. The largest ram in this group has a horn with a 49½-inch curve—the world's record



Reproducing a cactus for a desert setting, an artist transfers spines from a real cactus to a balsa-wood body, placing each pricker individually. Plants, trees, and grasses are copied with similar exactitude

To make a floor for one of the exhibits, wire netting is laid over a framework to give the desired contour. This is covered with plaster as a base for the artificial flora. Rocks and pebbles often are brought from the site represented

# INDUSTRY'S MASKED MEN

HELMETS, gas masks, eye shields, respirators, rubber gloves, tough leather bibs. These are indispensable guardians of the eyes, lungs, and hides of many of America's industrial war workers today. Without them, injuries would sabotage and cripple production of planes and arms for the United Nations' fighting forces. Commonest of the devices are pictured here.

Gas mask, worker style. It filters deadly fumes of metal-spray gun

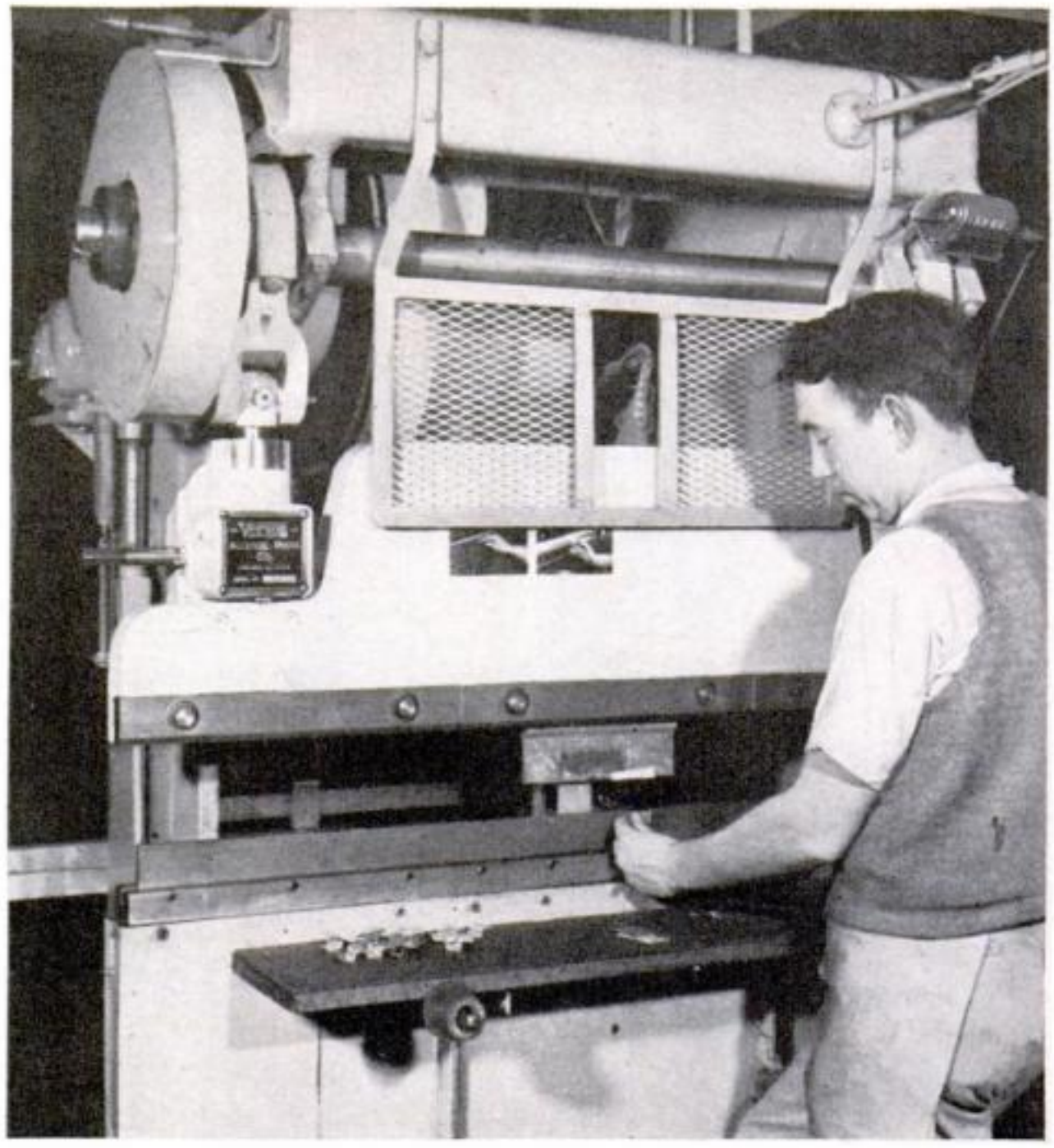
Left, respirator is proof against inhaling particles of sand from sand-blasting booth in which cap nuts shown are treated

Helmet, below, guards plane sprayer's eyes and lungs

Blinding heat and light sear harmlessly at the arc welder's mask. Eye shield is nearly opaque

## Safety-First Color Scheme Marks Moving Parts on Machines

WORKERS who build Lockheed planes now are protected by a safety-first color scheme applied to their machines. Moving parts are identified by cream-colored paint, and stationary parts by gray, as in the brake for bending sheet metal shown at right. In other applications, suitable colors make control levers and knobs more clearly visible. Fourteen daylight trials show the best contrasts to be black against a yellow background, and green against white; the worst, red against green, and blue against red. Among industries using complicated piping systems, paints of different colors long have been used to distinguish pipes carrying water, steam, gas, refrigerant, acid, and various other chemicals.



## First-Aid Kit Worn Like a Belt Leaves the Hands Free

WORN around the waist like a belt, a new kit enables a civilian defense worker to administer first aid in an emergency, while allowing free use of both hands at all times. Opening the snap-fastened flap of the water-repellent container gives access to preparations for burns and shell wounds, bandages of varied types and sizes, adhesive tape, scissors, skin-marking pencil, and note pencil. Strongly stitched pockets keep the contents neatly arranged and ready for instant use whenever they are needed.


Strongly stitched pockets keep bandages, medicines, and accessories in order and ready for instant use

# More Small Shops Get into War Work

WHAT YOU CAN DO FOR VICTORY

**THE WPB CO-OPERATES IN ORGANIZING EXPERIMENTAL SET-UPS IN VARIOUS DISTRICTS . . . LARGE INDIANA MANUFACTURER PLANS EXTENSIVE USE OF FACILITIES UNCOVERED IN THE POPULAR SCIENCE SURVEY . . . HOW VICTORY POOL NO. I OPERATES IN CLEVELAND**

**By ARTHUR GRAHAME**

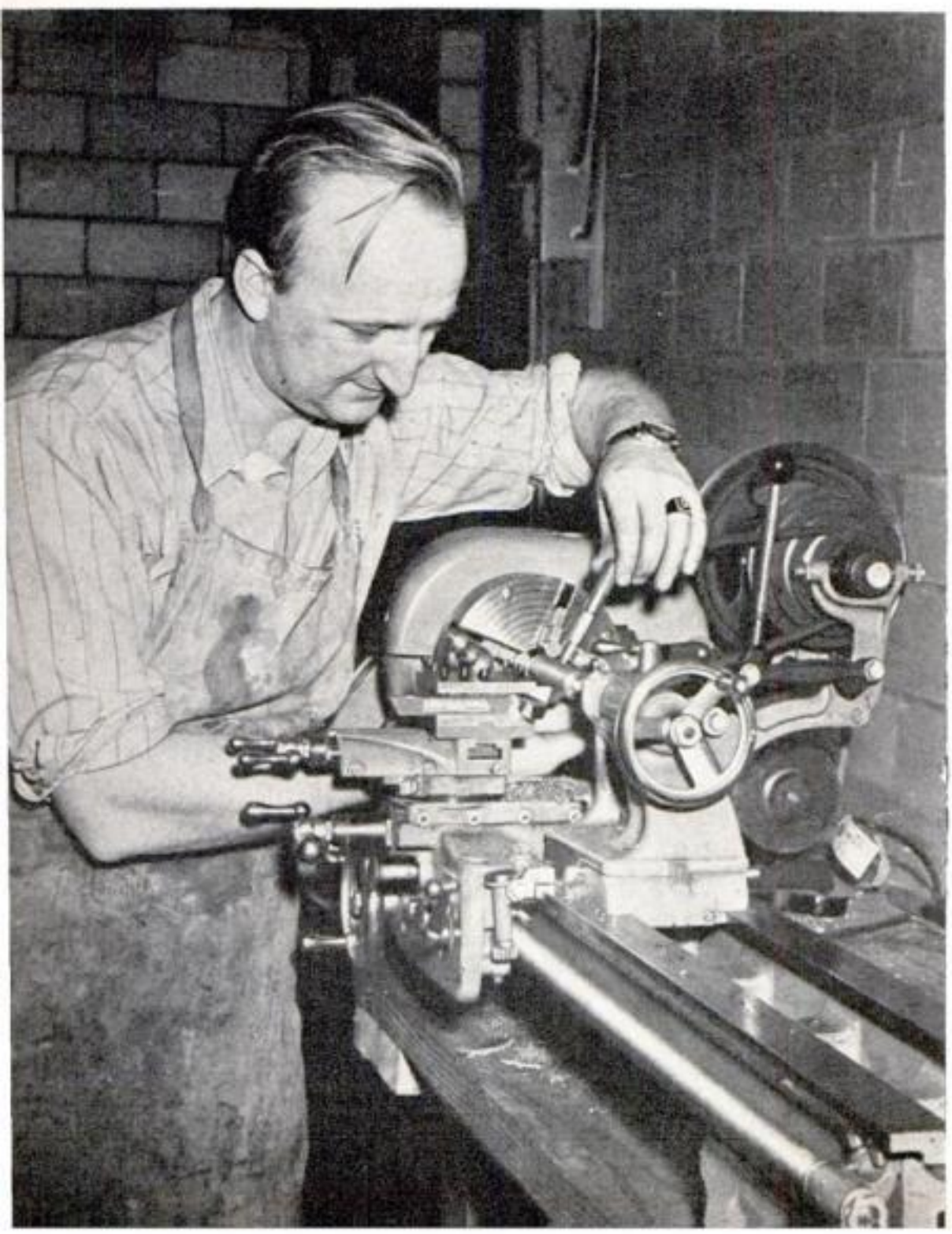
THE War Production Board is trying to develop a practicable method of bringing many of the nation's hundreds of thousands of home workshops, back-street machine shops, converted garages, and very small manufacturing plants into the war-production drive. With this purpose WPB field offices in several parts of the country are co-operating with prime contractors and small-shop owners in the experimental organization of facilities for turning out the innumerable small parts which must constantly be fed to big industry's assembly lines.

The largest-scale experiment is being conducted in the southern Indiana district under the joint leadership of Servel, Inc. and the Contract Distribution Branch of WPB working through its field office.

In peacetime Servel was an important manufacturer of refrigerating apparatus and kindred products. Now all its facilities have been or are being converted to war production, and the company holds large contracts for a wide variety of armament and munitions items.

When the Servel production engineers began planning for increased manufacture of these war items, they found it advisable to subcontract the making of many parts. They offered this work to smaller plants, but could not place their subcontracts because all the shops which were tooled up to do their work already were operating at full capacity. Conversion of some of the facilities of the Servel factories, badly needed for other war production, seemed to be the only way of getting the vitally necessary parts.

While this undesired conversion was being considered, an executive of the company read the article in the March issue of POPULAR SCIENCE telling of the success of a New Jersey manufacturer, Stanley A. Carlson, in obtaining increased production from his two small plants by subcontracting to home workshops. Analysis of war-work registration forms submitted by home-workshop hobbyists and others in the survey conducted by POPULAR SCIENCE for WPB convinced the Servel management that in the home workshops and other small shops of the country there is a tremendous reserve of efficient machine tools and skilled workers which would be available *immediately*—



George Hoernig, a P.S.M. reader, organized a group of six home craftsmen in his Ohio city for war subcontracting. After a day's work at a naval-ordnance plant, he puts in six hours in his shop

Charles C. Doyle, president of the J. E. Doyle Co., is the organizer and production chief of Cleveland's "Victory Pool No. 1." Before the war, his firm made infrared driers for printing presses. Now he bosses a production line of small shops that stretches for 18 miles

One of Doyle's pool members is the proprietor of a one-man brazing and welding shop. This is not the first time that his skill has helped Uncle Sam to win a war; in the last one, he taught welding to doughboys in France


Cleveland's tiniest "war industry" is a backyard workshop in which a defense-plant toolmaker used to run a spare-time business making gasoline engines for airplane models. The war stopped the supply of material for model-plane engines, and the toolmaker was glad to join up as one of the links of Doyle's chain

if a way could be devised to organize them so that they could fit into the larger pictures of big-industry war production.

After consultation with Contract Distribution Branch officials in Washington, Servel, with the close and enthusiastic co-operation of Ralph C. Hubert, manager of the southern Indiana WPB office, started an experimental organizing campaign designed to reach every home-workshop and other small-shop owner within a radius of 100 miles. Hubert talked on the radio, and the co-operation of the newspapers was obtained to insure widespread and continuing publicity. Ten thousand questionnaires, similar to the war-work registration forms used in the POPULAR SCIENCE survey, were distributed among workmen in industrial plants in the district, and among city high-school students. Registrants in the POPULAR SCIENCE survey are being given full consideration.

As we go to press this experimental organization still is in the preliminary stage of locating small-shop facilities and skilled workers who are able to devote all or part of their time to war-production work. It must be remembered that this project is purely experimental, that even the best-conducted experiments don't always succeed, and that home-workshop subcontracting is an emergency method of increasing production which is full of difficulties and headaches. But if these inherent difficulties can be overcome, it may very well show how home workshops and other small shops all over the country can be brought into the war-production drive.

An Ohio home-workshop hobbyist has obtained so many war-production subcontracts

From a basement shop in this suburban home come tools, dies, and jigs for pool members. Arthur J. Allen, tool designer and engineer, read about Dayle's pool and joined up. Below, he is seen at work in his shop, where he has about $7,500 worth of tools and equipment, including lathe, milling machine, drill presses, foot press, vertical surface grinder, and a grinder he made himself

that he is trying to sub-subcontract much of his work to other home-workshop owners!

WPB's Canton office is co-operating with him by locating men who have the machine tools and the particular skills necessary for doing his particular jobs. All Canton district registrants in the POPULAR SCIENCE survey are being given consideration.

This successful home-workshop manufacturer is George Hoernig, who holds a very responsible position in a big war-production plant. An ardent home-workshop fan and a long-time reader of POPULAR SCIENCE, Hoernig recently built a new home which features a basement workshop equipped with a lathe and a drill press. He had read a lot about one-man shops, and when the desperate need for increased war production became apparent he resolved to devote his leisure hours and his skill with machine tools to helping to produce the weapons which our fighting men must have to put the skids under Hitler and Hirohito. With this end in view he formed a partnership with Anthony Pesco, an expert tool and die maker employed in his plant, and a fellow home-workshop hobbyist. Then he called on E. O. Kuendig, the manager of the Canton WPB office, and told him what he wanted to do. Kuendig leafed through his requirements book and found a Cleveland prime contractor who wanted to subcontract some work that Hoernig could do. Hoernig went to Cleveland, and came back with a $7,000 order. Others followed it, and he now has a backlog of small orders for 50 different ordnance parts.

Hoernig began looking around for fellow home-workshop enthusiasts with whom he could share his work. He found four, each of them the owner of a good lathe. With Mrs. Hoernig acting as full-time secretary of their informal pool, they went after and landed more orders, and added two shapers, a welding outfit, a power hack saw, and a hand milling machine to their collective tool equipment. Each of the pool members works from six to twelve or one o'clock every evening, and puts in a solid ten hours on Sundays. But in spite of their efforts their production isn't large enough to keep up with their orders, and they are anxious for other men to join them.

Working through WPB field offices, the Contract Distribution Branch is doing experimental work in the organization of small-shop and home-workshop subcontract-

War production hits the campus: instead of doing routine work for machine-shop practice, students of engineering at Purdue University turn out war-materials parts under a subcontract. Here C. A. Haag, veteran shop instructor, inspects the work of William E. Rose, a sophomore electrical-engineering student

Priscilla Hendricks, one of 15 co-eds majoring in engineering at Purdue, uses a dial indicator made in the school shops to check the accuracy of parts turned out by fellow students at the machines

ing in several other districts in which interest in this method of upping war production is especially keen. In all these experiments, use is being made of the war-work registration forms submitted in the POPULAR SCIENCE survey. I hope to be able to report some progress on them in the next issue.

In Ohio, a war-production organization known as Victory Pool No. 1 has a production line 18 miles long!

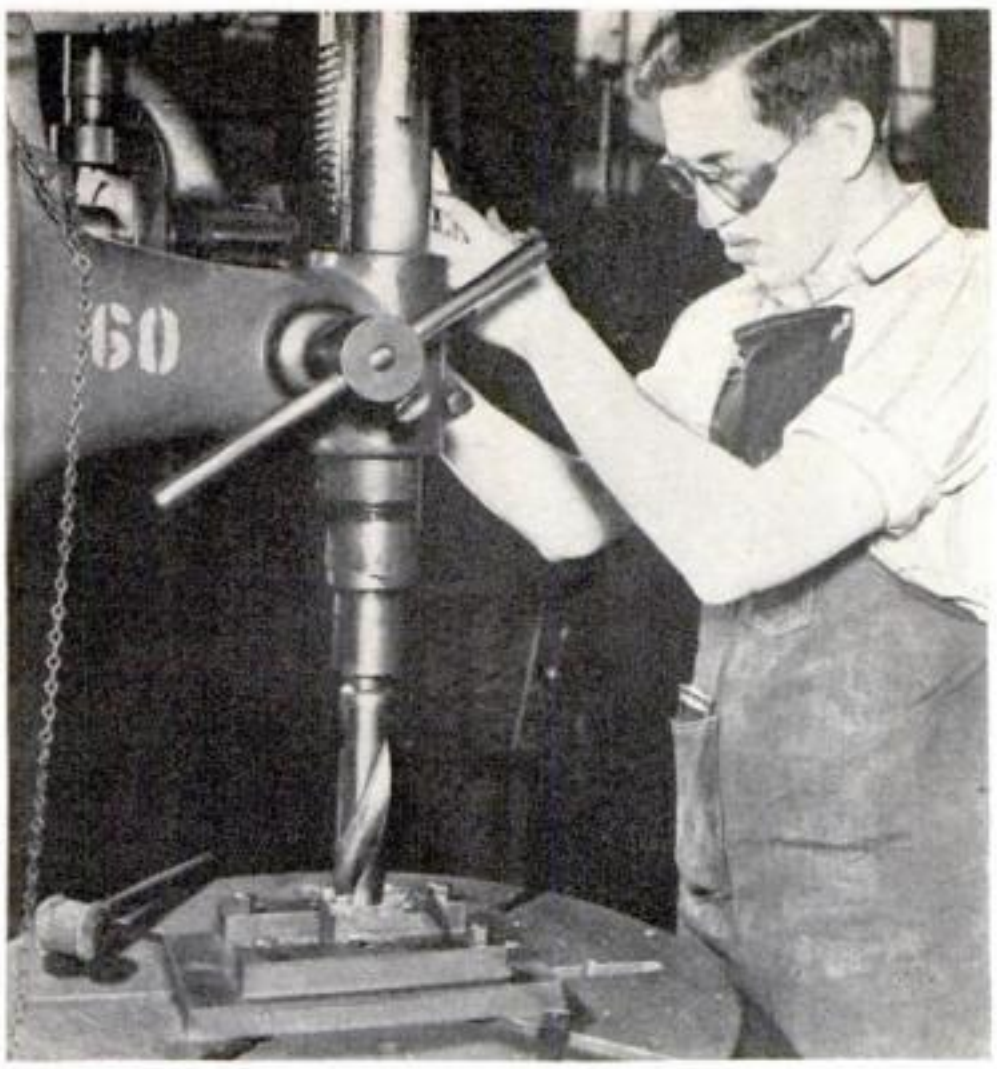
Composed mostly of home workshops, converted garages, and other very small shops, this production line stretches from a little brass foundry in downtown Cleveland to a jeweler's one-man basement shop out in a suburb.

Organizer and spark plug of this remarkable pool is Charles G. Doyle, prominent in the printing industry and president of the J. E. Doyle Company, peacetime manufacturers of infra-red-ray dryers and other special printing equipment.

When the demands of total war forced the makers of printing presses into armament making, the demand for ink dryers fell off, and Doyle began accepting small war-production subcontracts which kept his plant, and the plants of several small manufacturers who had made parts for his dryers, in operation. His first order was for a gun-sight part, and it proved to him that big industry hasn't any corner on talent, and that the finest sort of work can be done and extremely close tolerances held by good craftsmen working in very small shops—even in basement home workshops. The gun-sight parts were produced in the basement of a jewelry store—produced more quickly and at lower cost than a big factory could have turned them out.

Other war orders followed, and to handle them Doyle organized Victory Pool No. 1, operating through the J. E. Doyle Company, which takes care of getting the contracts and provides the members with managerial and technical services. Small manufacturers, alley machine shops, converted garages, and home workshops joined the pool. It now has 87 members. Among them are a peacetime manufacturer of folding wheelbarrows, a maker of chicken-picking machines, a one-man shop which specializes in coffin plates, and a man who in peacetime never made anything but special hinges. A large majority of the members are home-workshop owners.

Victory Pool No. 1 got its biggest contract when a large manufacturer found that he had to have holes drilled through hundreds of thousands of small metal parts. This unexpected drilling caused a serious bottleneck—which Charley Doyle's organization broke in a hurry. This work probably will continue "for the duration." Nearly all of it is being done in home workshops, and the



A student production soldier: Charles Turner, of Greenville, Ky., operating a drill press in the Purdue machine shops. Placing of the subcontract with the University brought 275 engineering students into active work for the production program

number is being increased as fast as drills and jigs can be provided.

Doyle is convinced that pools such as his can bring into our war effort vast reserves of equipment and labor which do not compete with existing war-production facilities and which are available immediately, and that if profiteers and exploiters are kept out there are wonderful opportunities for the expansion of this sort of manufacturing.

Although some large manufacturing corporations still are inclined to look down their corporate noses at the small-shop owner who asks them for an order, many others realize the value and necessity of subcontracting as much of their work as possible. Westinghouse is one of these far-seeing corporations. Over 300 smaller manufacturers in 26 states now are working on Westinghouse subcontracts totaling over $32,000,000 —the largest of them for $4,000,000 and the smallest for $8. Recently a subcontract was given the Purdue University student machine shops. Working on it are 275 engineering undergraduates—15 of them co-eds—who are taking shop courses. They give the same number of hours to war production that they normally devote to practice work, and their output is equivalent to that of a 75-man shop working full time. The student machine shops are being operated on a strictly production basis, with the instructors serving as foremen.

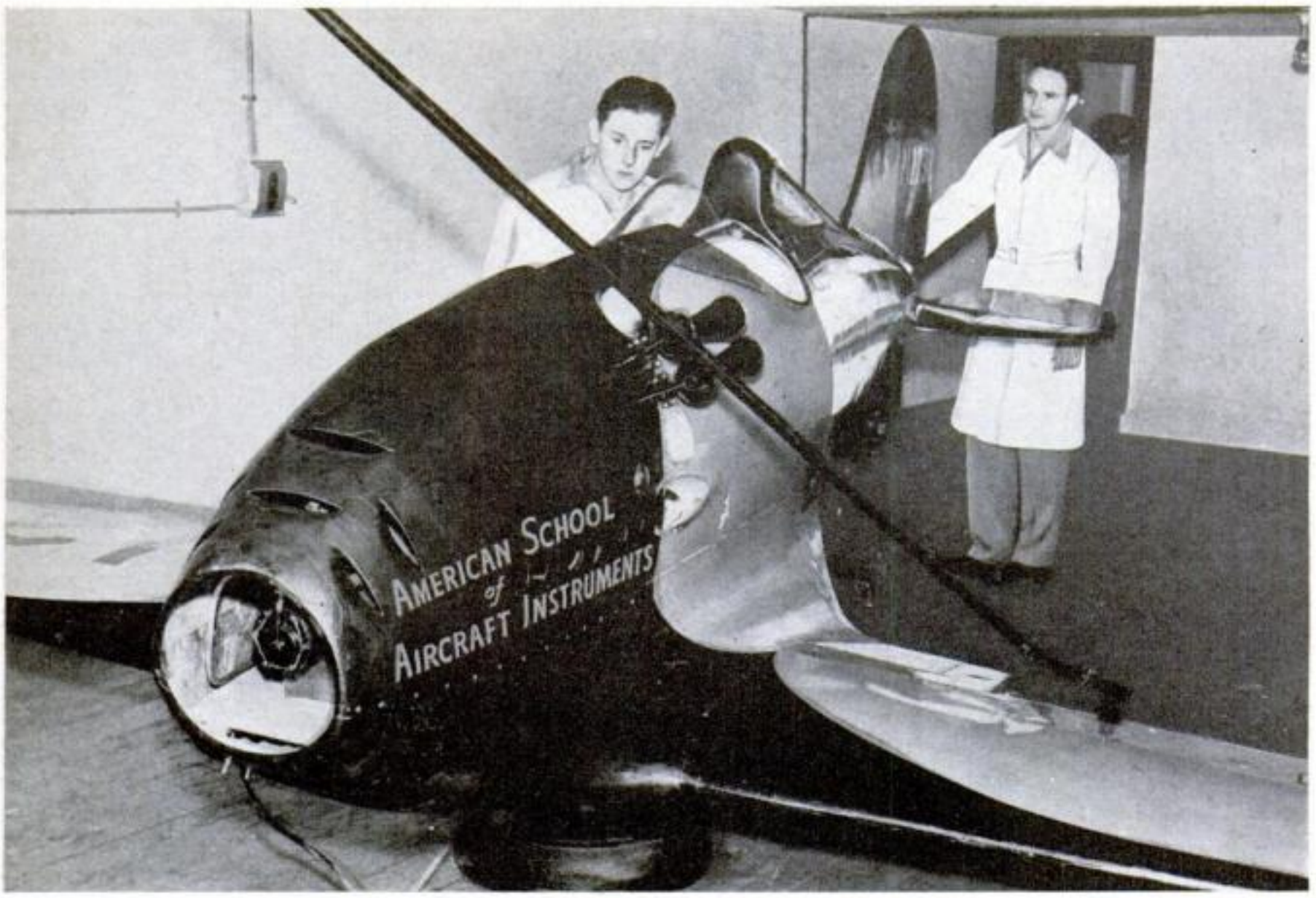
All over the country small manufacturers and the owners of back-street shops are getting into the war-production drive. Many automobile dealers whose equipment includes machine tools have obtained war orders. A little factory that used to make children's games is working overtime turning out gauges for Army arsenals. A manufacturer of merry-go-rounds is making metal towers used for servicing bombers, and jigs and fixtures needed for the large-scale production of tanks and gun mounts. A small plant which in peacetime made beverage containers now is engaged in the mass production of oxygen cylinders necessary for high-altitude flying. Near New York City a naturalized Norwegian boat builder who retired in his late sixties is back at work in his one-man shop turning out specialized hardware for a maker of yacht sails who is producing various canvas items.

Tremendous as the production of "bits and pieces" has become, much more of it is needed. We hear so much these days about bombers, tanks, guns, and even ships rolling off the assembly lines that it is easy to forget that assembly lines *finish* production but that they don't *start* it. Production must start with the turning out of the hundreds of thousands of separate pieces that go into the building of the complex weapons of mechanized war—the forgings, castings, gears, shafts, bolts, knobs, pins, collars, and other parts, large and small, that must be fed steadily and punctually to the assembly lines of big industry for them to turn out the weapons needed so desperately by our fighting men and those of our allies.

### REGISTER FOR WAR WORK

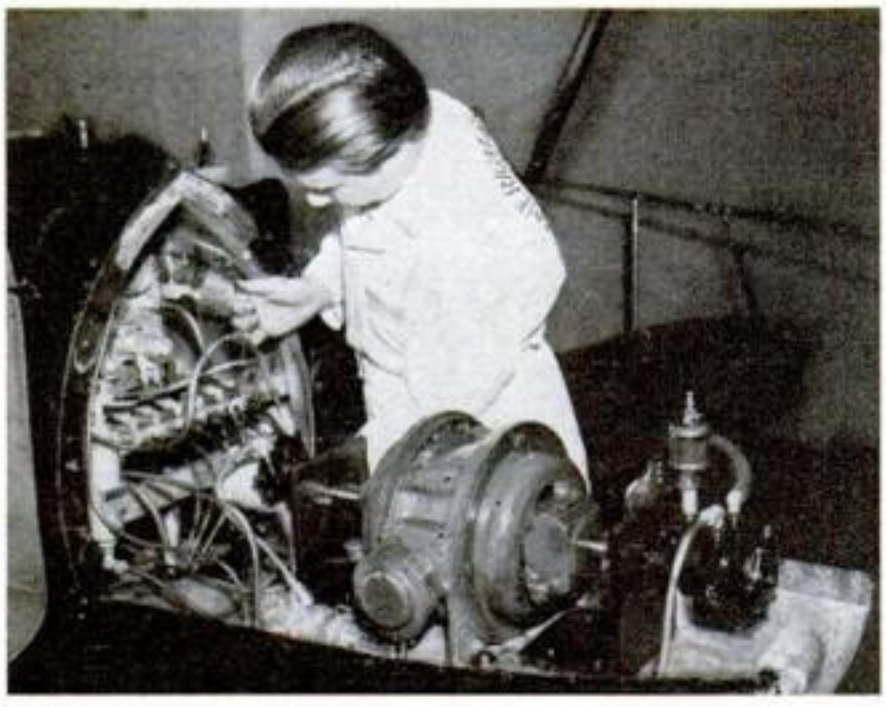
If you have a well-equipped home workshop or are the owner of any type of small shop suitable for producing "bits and pieces," you should register in the survey being conducted by this magazine for the War Production Board. Write to War-Work Registration, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, for a registration form, and inclose a stamped, self-addressed envelope. The blank has spaces in which you can list your shop equipment and indicate the kind of work you are best fitted to do. Act at once . . . write today.

# Dummy Plane Shows Students How Aviation Instruments Work

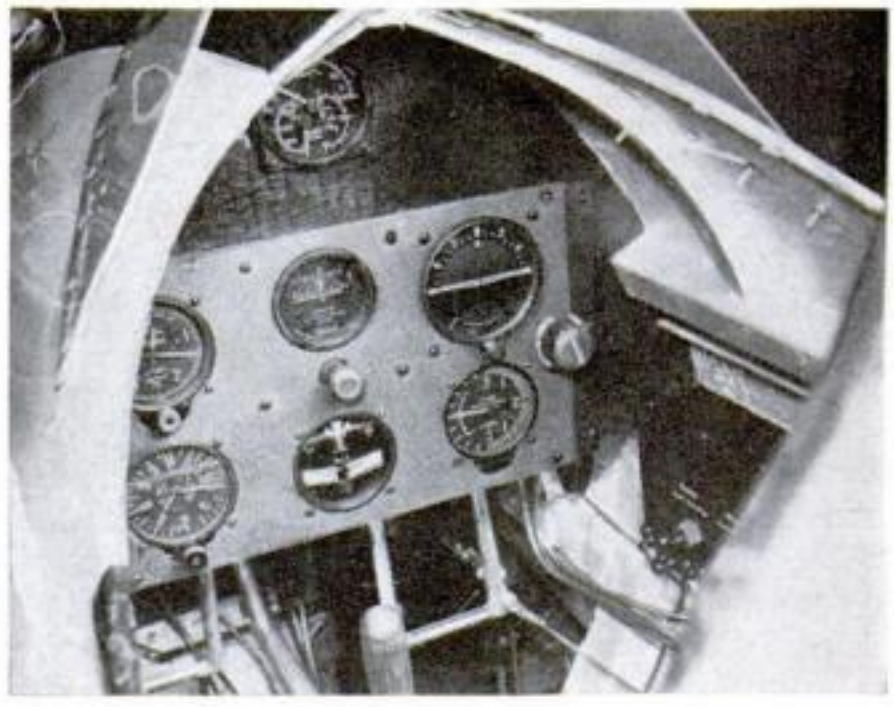



While one pupil operates a motor at the tail of the plane, another checks the instruments in the cockpit

THE closest possible approach to true-flight observation and tests of the instruments they are studying is afforded students at the American School of Aircraft Instruments, Glendale, Calif., by the trim earth-bound monoplane pictured above. The plane, a former racing craft, is mounted on a universal-joint base upon which it is made to roll, yaw, and pitch. Simultaneously, instruments being checked in the craft register the movements on dials by means of vacuum and hydraulic systems sensitive to movements of the regulation plane controls. Placed in attitudes of level flight, banks, dives, and climbs, the realistic plane brings to life for the students the operating principles they have learned as well as the success or failure of the repair work they have done. Vacuum, hydraulic, and electric systems of the craft copy so perfectly those of real ships that students may also obtain instrument-installation practice.



At picture's center is the motor that drives vacuum and oil-pressure pumps to power an automatic pilot



An instrument panel mounted for observation under flight conditions to test out class-room theories

# NavyGunnersDefy Cold Sea Winds in

# *Felt Face Masks*

THE U. S. Navy has satisfied the widespread curiosity about the queer-looking masks worn by gun crews and other personnel of the North Atlantic Patrol by announcing that they are made of wool felt, and that they have been found to provide complete protection to the face in cold and stormy weather.

The section of the mask which immediately surrounds the eyes consists of an inside layer of soft white felt and an external layer of blue. Two layers of white felt form the balance of the lining. The outside layer is of dark-blue felt. A mouth flap can be opened for smoking and eating. The soft material holds warmth, and men of the service say the masks are comfortable and do not chafe the skin.

One of the "men from Mars" you have seen in pictures of the Navy's North Atlantic Patrol. He wears a face mask of wool felt for protection in cold and stormy weather when on duty

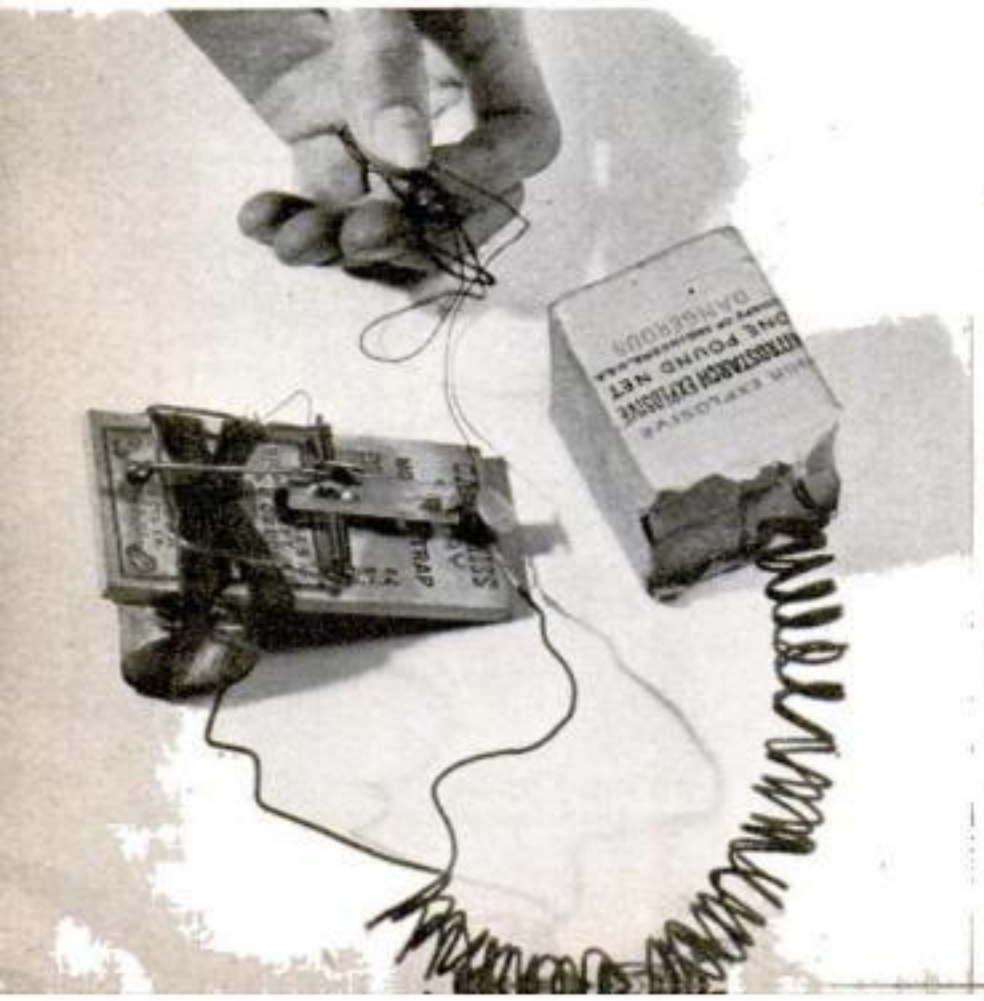
At the right is the inside of the mask, showing the lining of white felt which keeps it from chafing the skin. A flap over the mouth (far right) is opened for smoking and eating

# Deadly

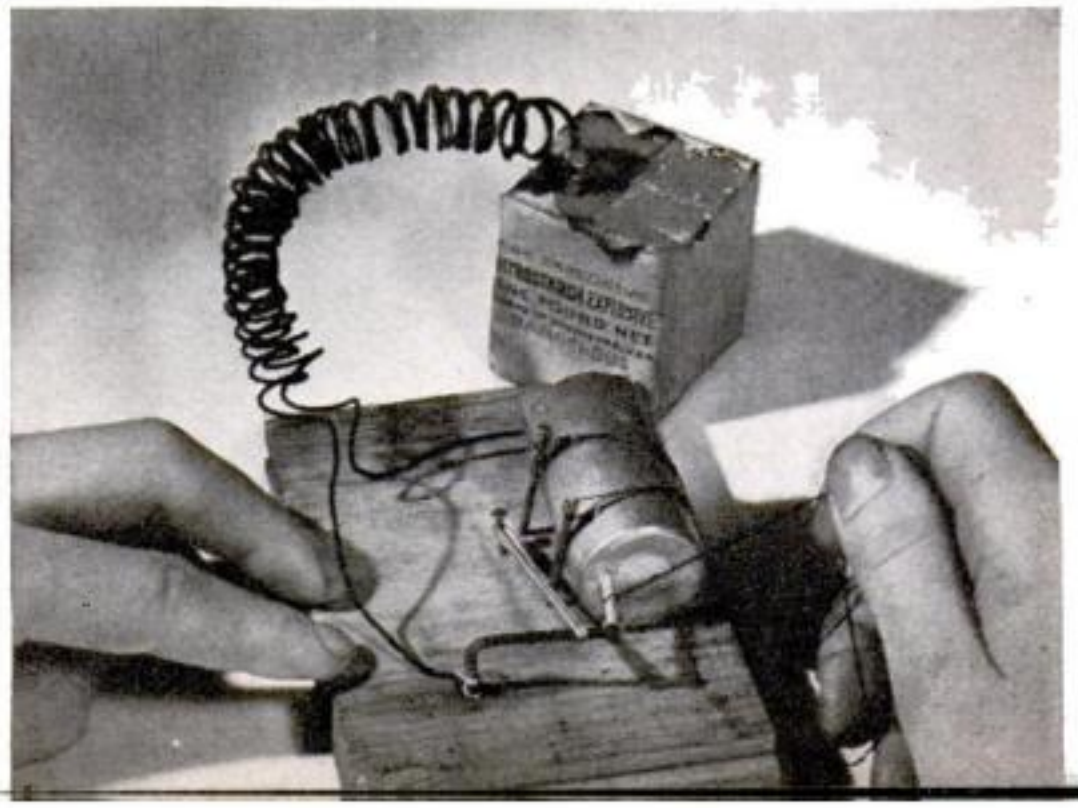
METHODS of blowing up an enemy and delaying an army's advance are reaching new perfection in this war of machines. Among the latest is an adaptation of the land mine to special destruction of the deadly tank. These mines, fruit of the experiments of demolition troops, are


Laying an antitank mine is almost as simple as taking a truck ride. The deadly explosives are slid down a chute from the tank-obstacle crew's truck in the way of a tank advance, and then camouflaged with leaves or dirt to look like the ground. The special detonator ring, shown on the mine at the top, right, will set off the blast of TNT when pressed down by the tank's weight

## TYPES OF MAKESHIFT MECHANISMS USED IN TRAPS




Nazi or Jap may be the mouse that springs the trap at left rigged with a dry cell to explode a mine. Below, a rubber band does the trick when the match is pulled



# Traps for Tanks and Men

easy to transport, can be laid quickly from a truck, and explode instantaneously when struck by the tread of a tank.

The mines consist of five pounds of TNT in a round metal container fitted with a detonator ring which sets off a detonator cap under the pressure of weight. One mine can be placed on top of another, or three or four can be laid in tiers, so that all explode at once. Handled by squads known as tank-obstacle crews, they are placed in strategic spots around an area to be protected, and then camouflaged with leaves, brush, or a light layer of dirt.

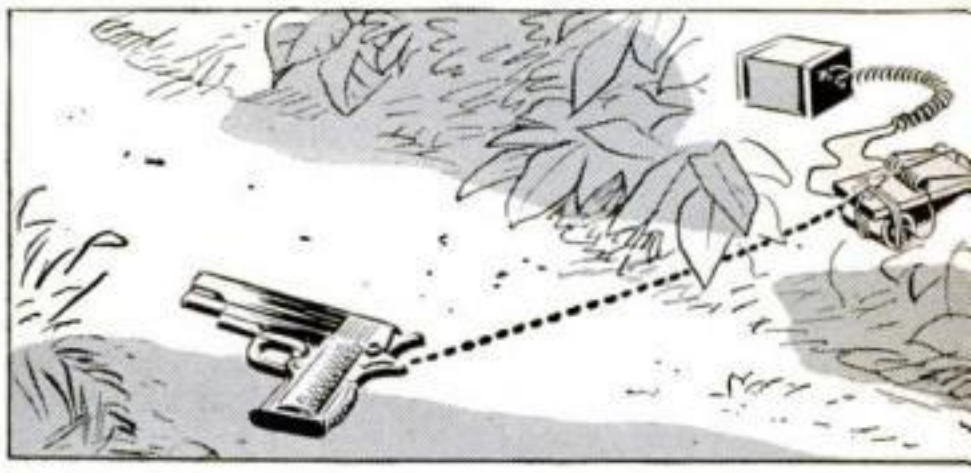
One old form of destruction, the explosive "booby trap," used extensively in the last war and the early days of the present war, is still a favorite of retreating soldiers, though its value lies chiefly in its nuisance element and effect on morale. Devising new ways of tricking enemy scouts and advance detachments is a test of ingenuity. An innocent-looking helmet, a food box, or an abandoned truck or plane, is bait left purposely in the path of an enemy and conceals a hair-trigger infernal machine that goes off when it is disturbed.

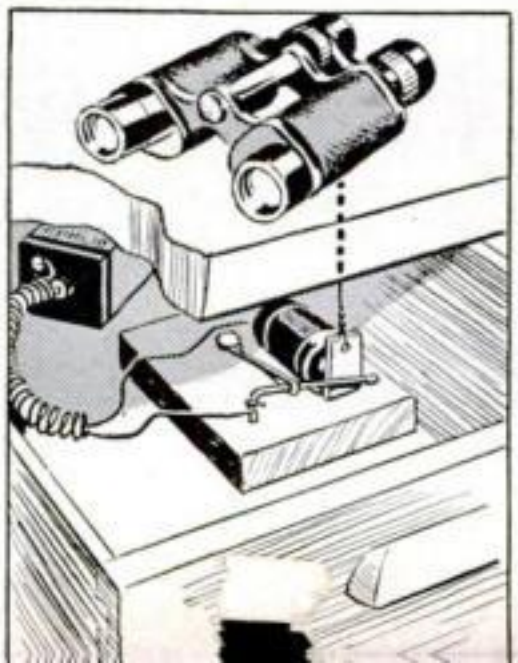
The mechanism is generally makeshift, and usually effective. Clothespins, mouse traps, old nails, simply contrived springs, and even rubber bands supply the trigger that closes a dry-cell battery's circuit and sets off the destructive charge. As for the bait, soldiers apparently have a hard time resisting that impulse to pick up objects left lying around, especially if they look like something that might contain food.

This knapsack left on the ground is enticing bait for an enemy scout. The soldier is wiring it to a charge of dynamite that will go off when the bag is picked up. All but the sack will be concealed

## FOR ADVANCING SOLDIERS

This clothespin snaps shut when released to close the electric circuit and blow up the unwary. The drawings at the right show how the mines are rigged up in the field





A mountain of rock salt. This is a reserve supply at a Niagara Falls plant where plentiful electric current extracts sodium and chlorine from salt

# SALT—WHITE MAGIC OF THE CHEMICAL INDUSTRY

An illustration from an ancient Chinese book shows how salt was obtained in 2700 B.C. by boiling sea water down "until an egg floats"

By KENNETH M. SWEZEY

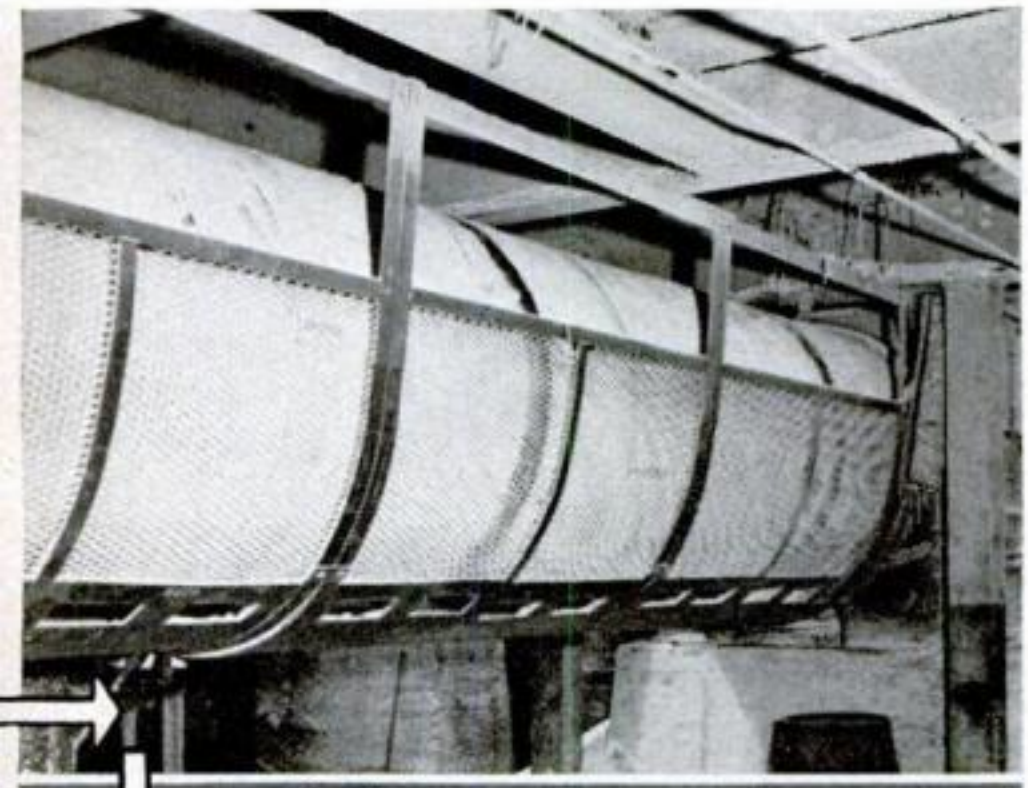
ALTHOUGH more than 10,000,000 tons of salt are used in this country every year, this is one substance, vital alike to health and to both peace and wartime industry, of which no shortage need be feared. According to scientists who have figured it out, the oceans alone contain enough salt to cover the United States with crystals a mile and a half deep. In addition to this immense quantity, 325,000 cubic miles of rock-salt deposits are known to exist in the earth. Under the state of Michigan alone there is enough salt to supply the needs of mankind for 200,000,000 years.

Only a few hundred thousand tons of the American production are used as table salt. Several million tons are used directly in in-

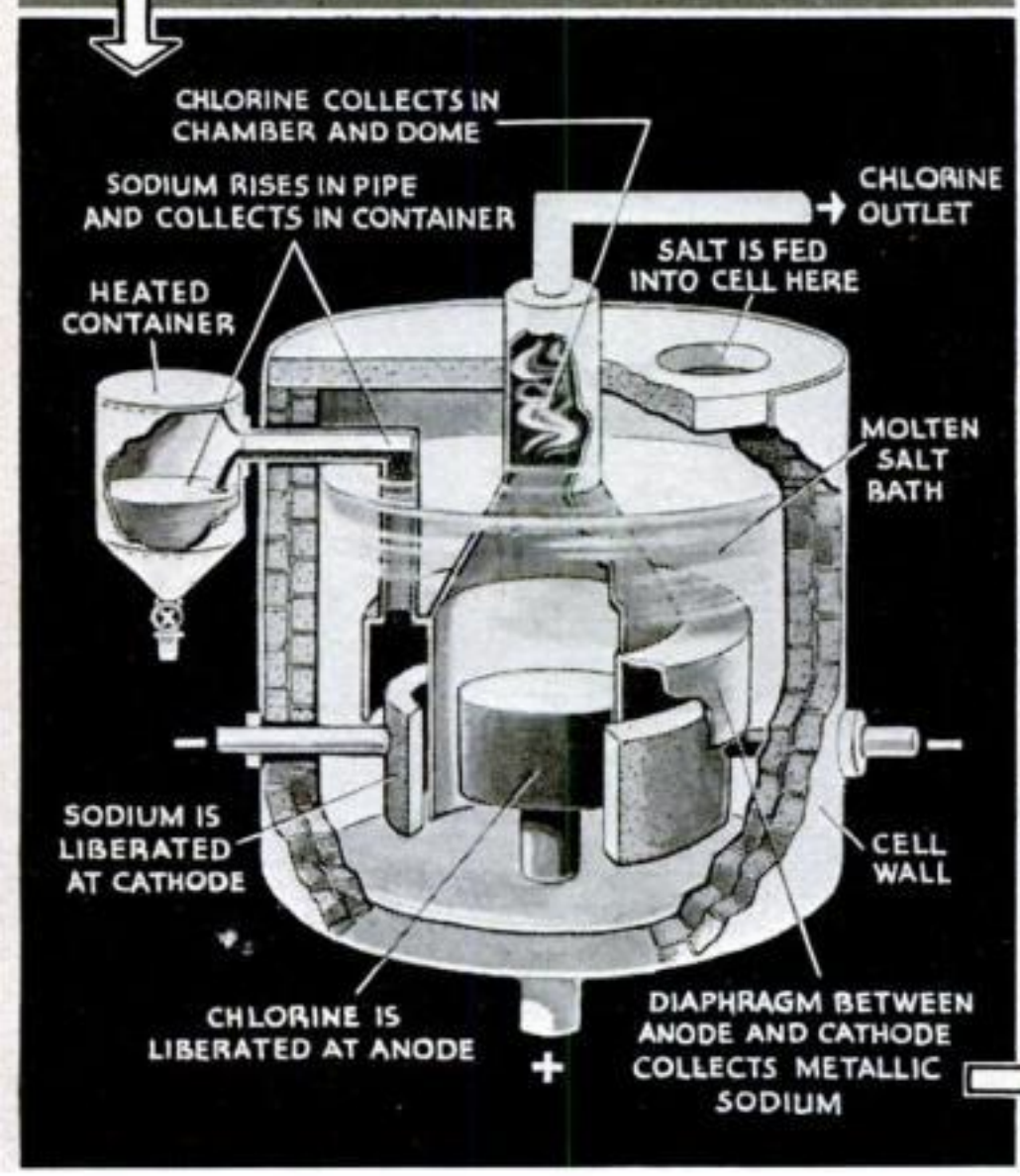
dustry, for preserving meat and fish, in baking and canning, in tanning leather, for salting butter, for freezing ice cream, and in general refrigeration. The remainder, about three fourths of the total, forms the basis of a chemical industry so vast that its products enter into the manufacture of most of the necessities and luxuries of modern life. Name almost anything produced by chemical means—glass, soap, rayon, dyes, bleaching powder, plastics, synthetic rubber, smokeless powder, ethyl gasoline—and the chances are ten to one that the common salt of your dinner table, which the chemist knows as sodium chloride, had a hand in its making.

Salt is of such vast importance because it is the cheapest and most plentiful source not only of sodium and chlorine, but of most of the dozens of compounds of these two elements. Chief of these compounds is sodium carbonate, more than 3,000,000 tons of which are used annually in the manufacture of glass, soap, pulp and paper, cleaning mixtures, and as the starting point in the production of other chemicals. Second is sodium hydroxide—sodium lye or caustic soda—necessary in making rayon and cellulose film, soap, chemicals, and in petroleum refining.

Chlorine, the gas, is third in tonnage produced, but second to none in importance. It is widely used in the bleaching of textiles and paper and in the purification of drinking water. Chlorinated hydrocarbons, such as trichlorethylene and perchlorethylene, are invaluable as dry-cleaning agents. Another large use of chlorine is in the treatment of sea water for the extraction of bromine, which is converted into ethylene dibromide for use with tetraethyl lead in making antiknock gasoline. Incidentally, the sodium used in making the sodium-lead alloy also comes from salt. The principal military uses of chlorine are the bleaching of cotton linters for making smokeless

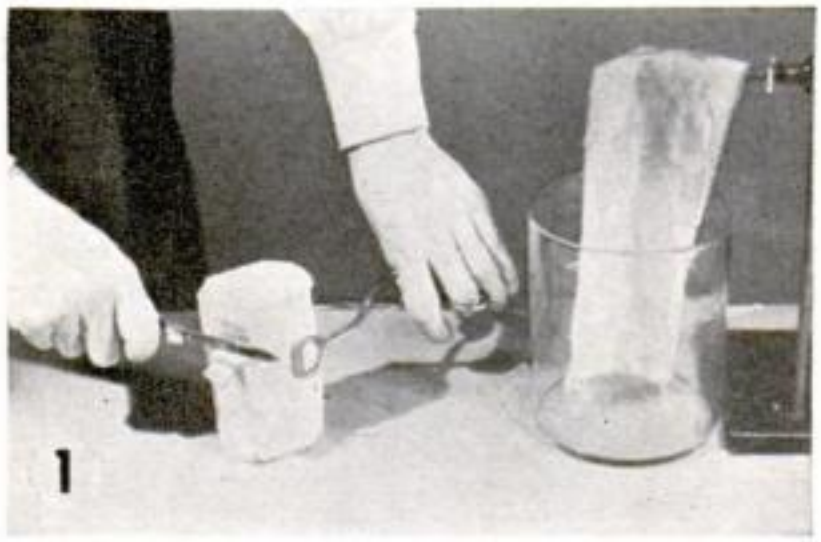


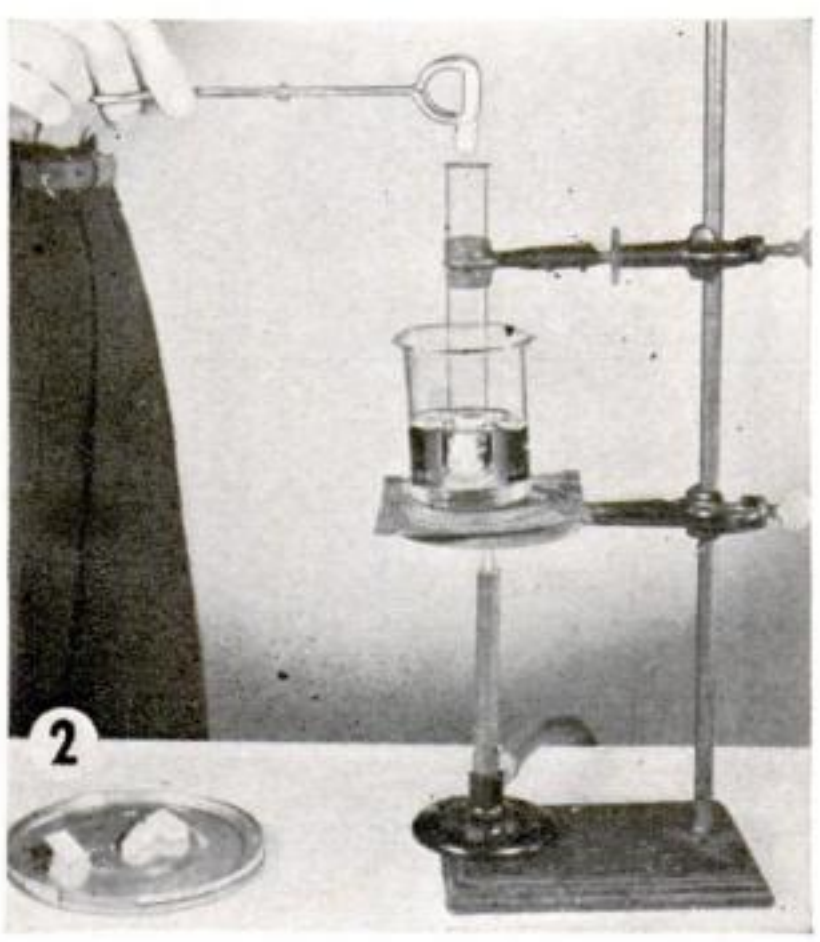
Purified salt is run through driers like this to make sure that all moisture has been taken out, before going to electrolytic cells like the one shown in the drawing below, where it will be broken down into sodium and chlorine



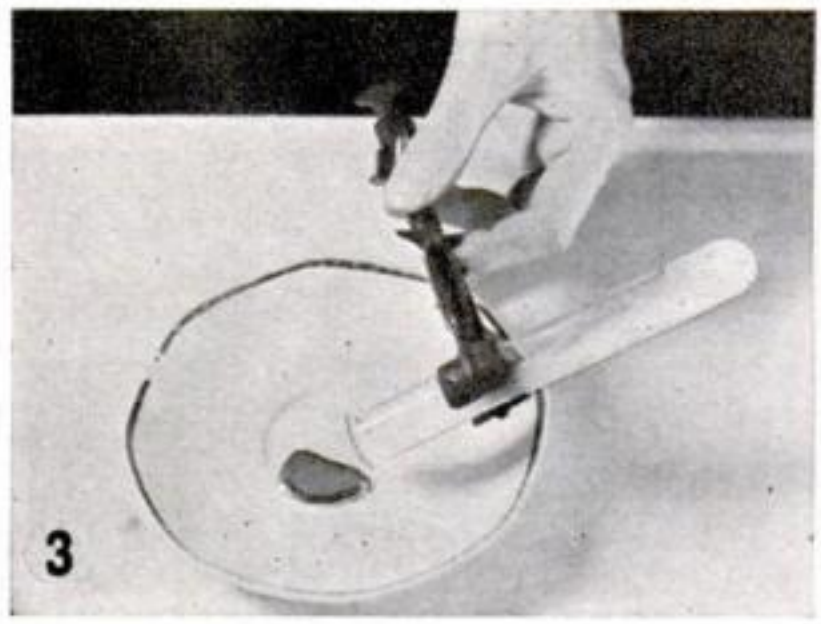

Sodium liberated by electrolysis at the cathode of the cell is led off into a heated container from which it is allowed to run in the molten state into molds as seen below. Here it rapidly solidifies into bricks ready for industrial use

## Low Melting Point Solves Problem of Transporting Sodium



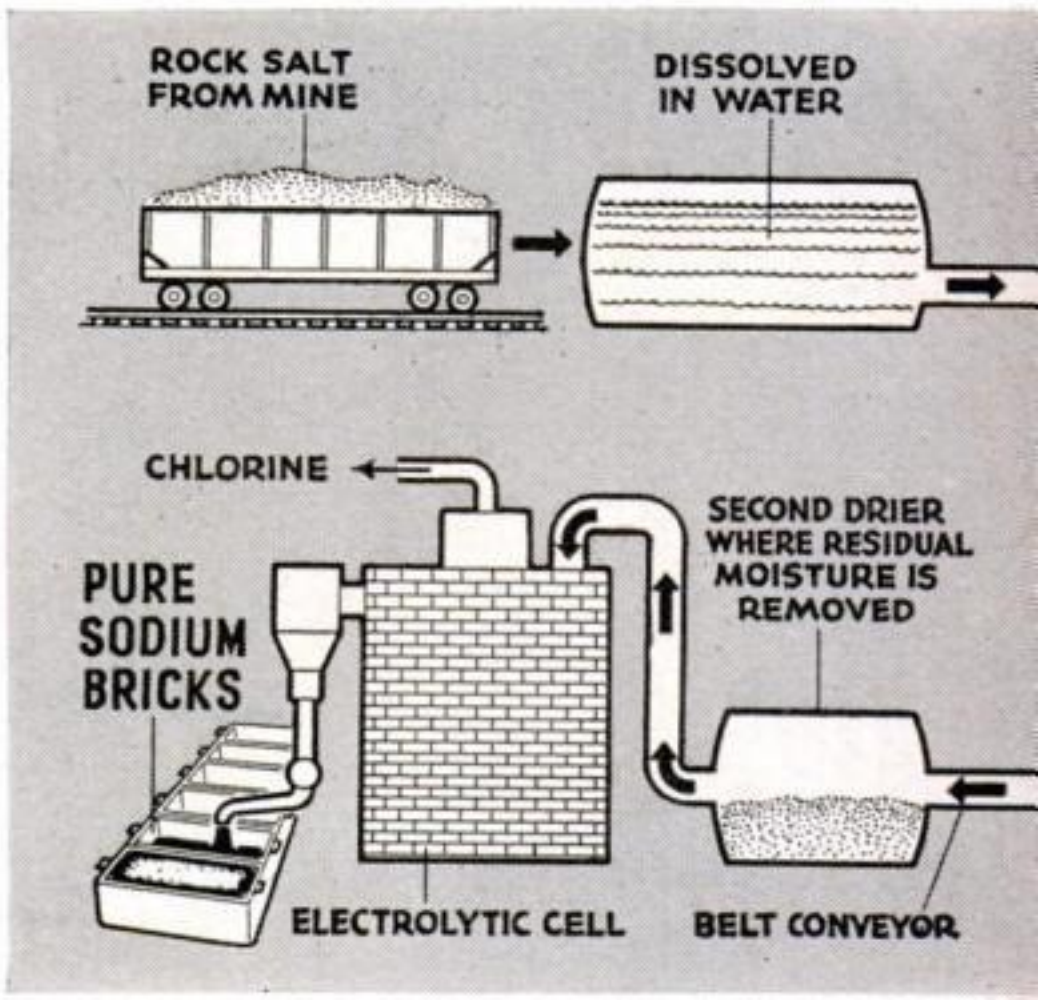

SODIUM melts at a temperature a little below the boiling point of water. This property, which is used in filling and emptying special tank cars to transport the metal from Du Pont's Niagara Falls plant, is demonstrated in the simple experiment illustrated. Pieces cut from a sodium brick (1) are melted in an oil bath (2). Poured out on a saucer (3), the molten metal looks like mercury. For loading in tank cars, the sodium is melted and pumped into the cars, where it is kept "frozen" by a circulation of chilled oil through channels welded on the inner shell. At its destination, the sodium is "thawed" by pumping hot oil through the same channels, and then can be removed from the car by means of additional pumping.




powder, in manufacturing war gases, and in making tetrachloride for smoke screens.

Hydrochloric acid, baking soda, chloroform, sodium cyanide, methyl chloride, sodium peroxide, and metallic sodium are just a few of the other chemicals made either directly from salt or through the reactions of sodium or chlorine compounds. One of three processes is generally used in breaking down sodium chloride into its constituent elements. By passing an electric current through salt brine, the sodium chloride solution is broken up by electrolysis into chlorine, hydrogen, and caustic soda. By passing a current through molten salt, the salt is decomposed into metallic sodium and chlorine.

At the R. & H. Chemicals Department plant of E. I. du Pont de Nemours & Co., we get a glimpse of that branch of the industry which changes common salt to sodium, chlorine, and a large group of related chemicals, by means of electric power.



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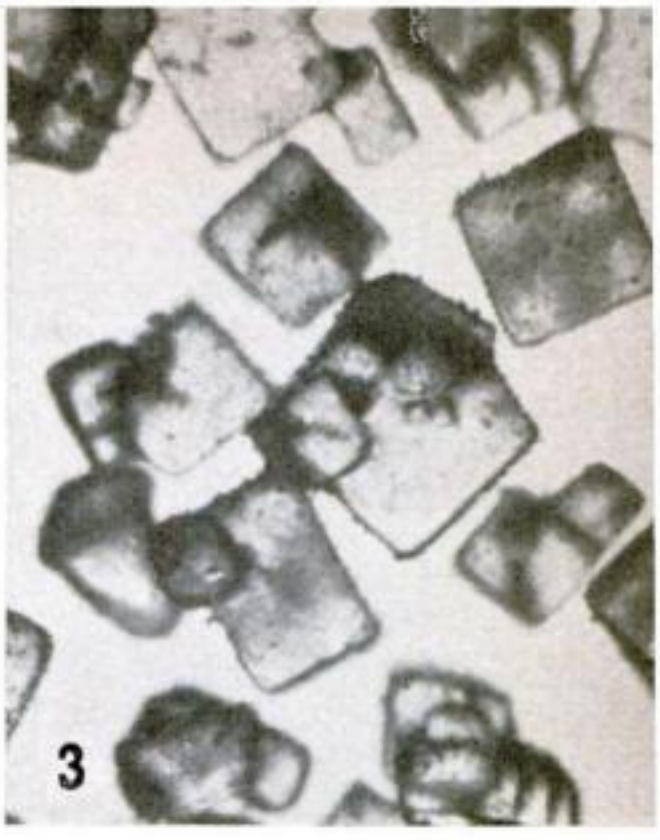
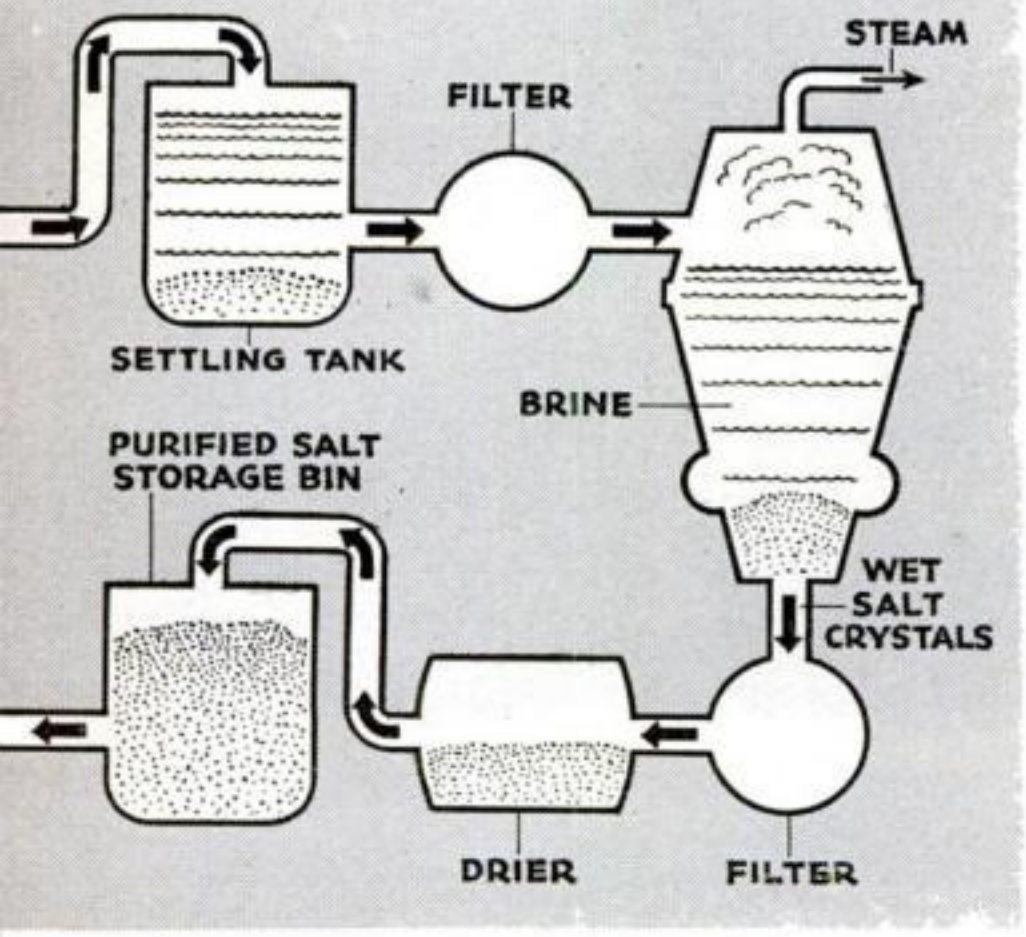


3

SALT CRYSTALS: (1) "Hopper-shaped" crystals drawn after a picture in the Peng-Tzao-Kan-Mu, oldest treatise of pharmacology, compared with (2) a modern photomicrograph of similar crystals produced by slow evaporation for use in food packing, salting pretzels, etc. Fine table salt comes from brine evaporated rapidly. Its crystals (3) show as regular cubes when seen under the microscope

EVAPORATION determines the size of the salt grains. When brine is evaporated slowly with no agitation, it yields coarse grains like those in the first pile at the right. This is flake salt made in open evaporating pans, or grainers. The pile at far right is table salt made by vacuum-pan evaporation. Only a small fraction of the salt produced is destined for table use




To remove impurities, the salt is first dissolved in water and treated chemically. The brine is then filtered, water is removed by boiling in huge evaporators, and the damp salt is conveyed to storage bins. As salt is needed it is thoroughly dried in big rotary driers, and the dry salt is then passed into electrolytic cells where it is broken down into silvery-white sodium metal, and chlorine, a greenish-yellow gas, by means of a powerful electric current.

The handling of molten sodium is a feat. The liquid metal is pumped through filters which remove impurities, and thence either to storage tanks and tank cars or through pipe lines to other operations. One of these sodium-carrying pipe lines is a quarter of a mile long. In the tank car the sodium is "frozen" by circulating cold oil through channels welded on the inner shell of the car. At its destination, the sodium is "thawed" out by pumping hot

oil through the channels, enabling the liquid sodium to be pumped from the car. Liquid sodium also is cast into 12½ or 24-pound bricks which are shipped to industry in water-tight steel drums.

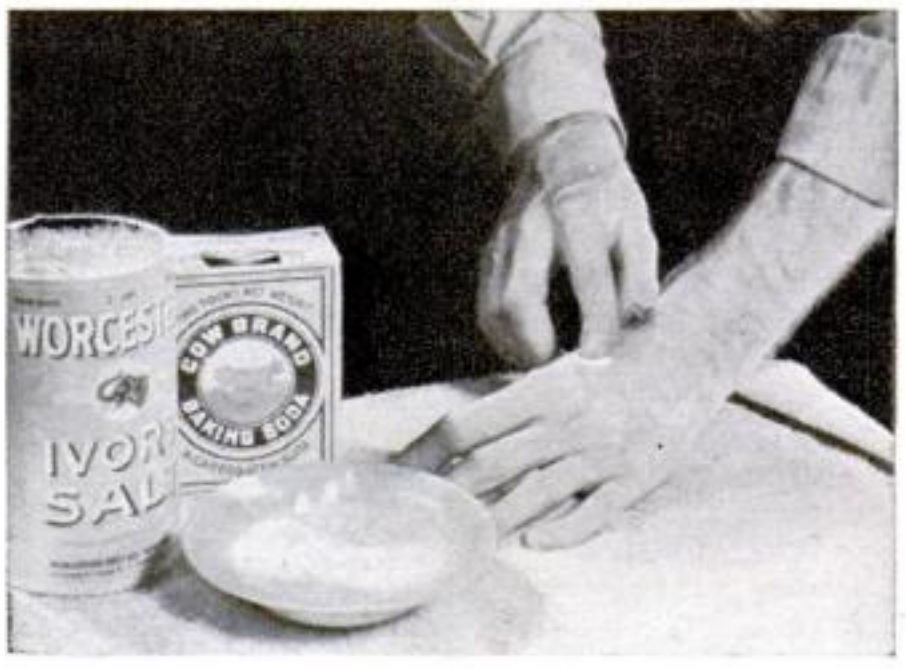
To make sodium cyanide, liquid sodium is reacted with liquefied ammonia and charcoal in large furnaces. The molten product is filtered and cast into pellets about the size of hen's eggs, each weighing an ounce. This product is important industrially for the surface hardening of metals, such as razor blades and automobile gears, in electroplating, fumigating, and as a reagent in the manufacture of organic chemicals.

Sodium peroxide, used largely for bleaching textiles, is made by loading sodium bricks into a large burner, where the sodium is melted and then oxidized with air to form sodium monoxide. This chemical is combined with oxygen in another burner to form sodium peroxide. Reacting sodium peroxide with borax produces sodium perborate, an important ingredient in modern tooth powders and mouth disinfectants.

Oddly enough, sodium and chlorine, two of the most active chemically of all the elements—so active that they are never found alone in nature—join in common salt to form one of the most stable compounds known. Sodium is so active a metal that if a bit is thrown on water it will immediately decompose the water, liberating hydrogen and forming sodium hydroxide. The heat

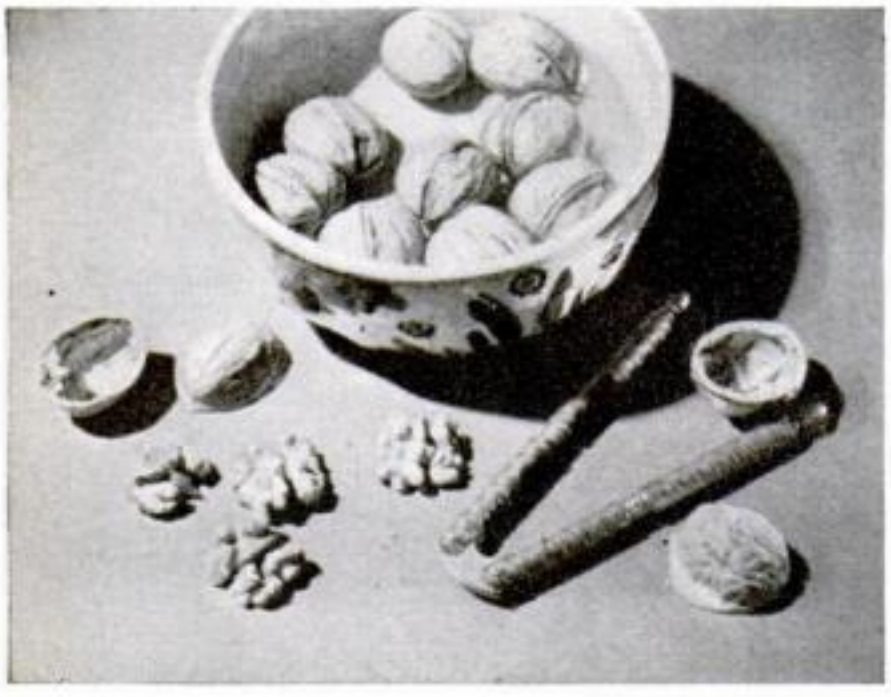
## HOUSEWIVES USE SALT BY PINCHES, INDUSTRY IN TONS:

CRACKED EGGS can be boiled without their contents oozing out if a teaspoonful of salt is added to the water. The salt balances the osmotic pressure, preventing transfer of fluids through shells




MOSQUITO BITES and other skin irritations stop itching if you apply a paste made by adding water to a mixture of equal parts of salt and bicarbonate of soda, or bathe in a solution of it

NUT MEATS will come out whole from their shells if you soak the nuts overnight in salt water before cracking them. Water expands the shells, and salt keeps the meats from losing flavor from soaking



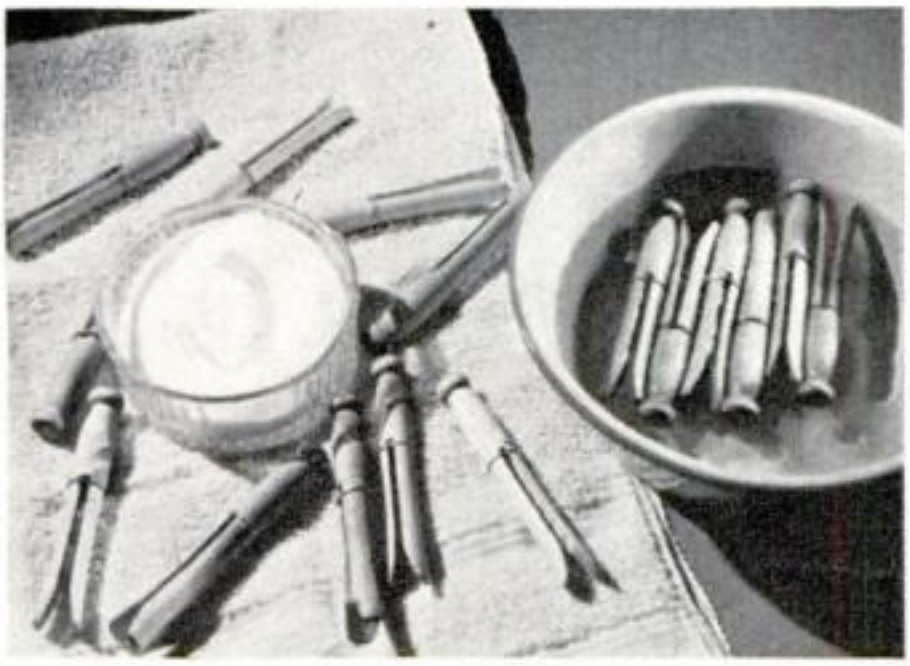
FLATIRONS that have become rough, rusty, or sticky from caked starch can be smoothed to a glass-like finish by rubbing the ironing surface with slightly dampened salt and a piece of rumpled paper

generated is generally so intense that the hydrogen catches fire. Sodium melts at a temperature below the boiling point of water, and molten sodium looks somewhat like mercury. Introduce molten sodium into a jar of chlorine, and the sodium will burst into a brilliant yellow flame. When it has burned out, the extremely active sodium and chlorine will both have vanished. In their place will be found a splattering of common salt!

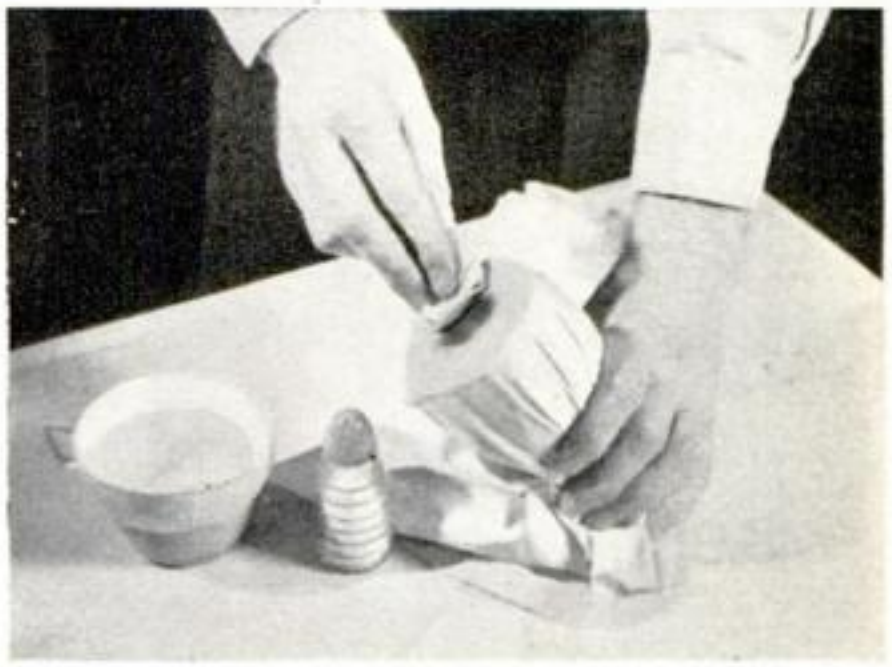
Rock salt and brines are used generally in the manufacturing of chemicals. Table salt, and the dozen or more grades of food salts, are made almost entirely from brines pumped from salt beds and evaporated either quickly in huge vacuum pans, or more slowly in open pans or "grainers." Fast evaporation produces cubical crystals of the finest table salt.

As an important article of diet and a preserver of food, salt has been known since the dawn of history, and its manufacture for these purposes is unquestionably the oldest inorganic chemical industry. The Phoenicians carried salt in their first ships. The Romans built roads expressly for traffic in salt. More wars have been fought over salt than over any other material. People have been taxed for salt, and salt has been used for money. Our modern word "salary," in fact, comes from the Latin "'salarium," a stipend to the Roman soldier for the purpose of buying salt.

## SOME UNCOMMON USES OF "COMMON" SALT IN THE HOME



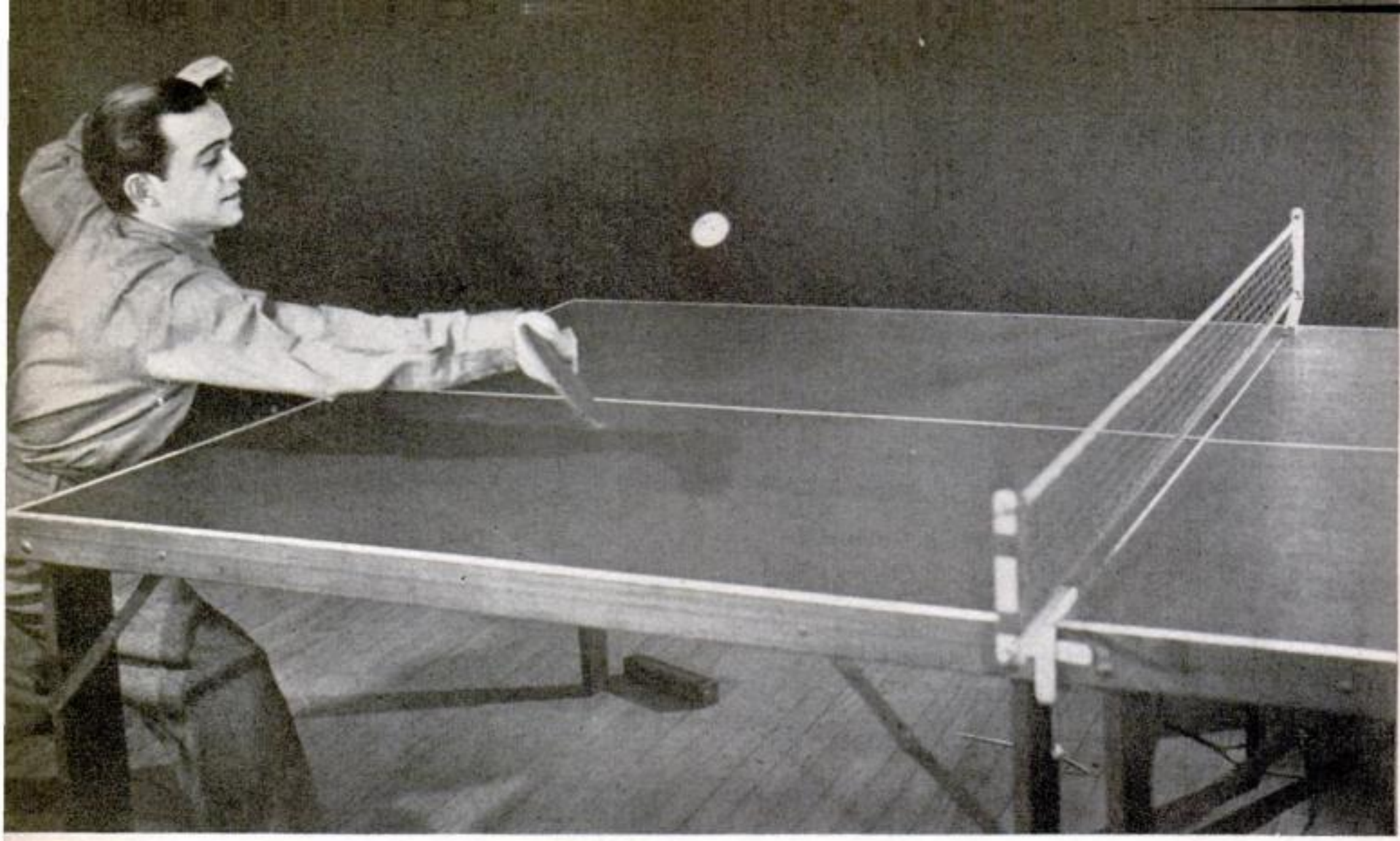
CLOTHESPINS that have been boiled in a strong salt solution will last longer and will not freeze onto clothes in cold weather. The little salt that comes out onto the clothes acts as an antifreeze



IN CLEANING washable fabrics with gasoline, you can avoid leaving a ring if you first rub on a strong solution of salt. Stretch the cloth over the end of a tumbler as shown in the illustration

TO SET COLORS in cotton goods before washing for the first time, soak the cloth for 20 minutes in cold water to which a handful of salt has been added. Salt in wash water keeps colors from running

BEFORE FRYING MEAT, sprinkle a little salt in the pan. This will prevent the splashing of the fat and meat juices during the frying, and some of the salt will be absorbed by the meat as seasoning



**Block** Louis Pagliaro, table-tennis ace, demonstrates the defensive block shot he recommends as practice for beginners. Using the backhand side of the bat at waist height, meet the ball with a gentle forward push. These photographs were made by Robert Smith at the Broadway Table-Tennis Courts, New York City

## AN EXPERT SHOWS HOW TO PLAY

# Table Tennis

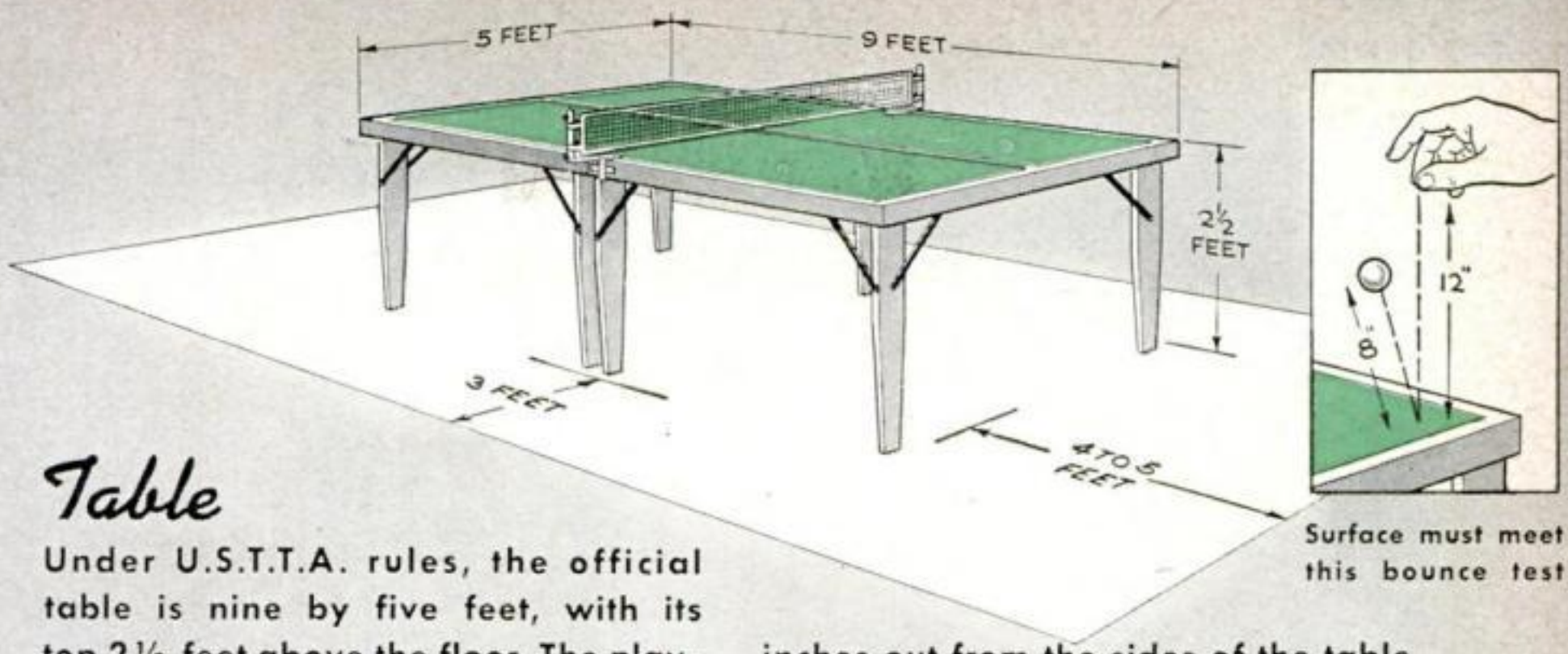
By AL LANEY

IF YOU want to have a lot of fun at little expense, and become reasonably skillful at one of the fastest sports in the world in a comparatively short time, table tennis is your game. Of all the bat-and-ball games, it is probably the one in which the beginner can have fun most quickly without spending much money.

Table tennis is no parlor diversion. It is one of the most spectacular games yet invented, with an international organization to which 25 nations are affiliated, holding annual world championship matches regularly before the war. But there is scarcely a home in all the land where it cannot be played by practically anyone strong enough to stand up and swing a five-ounce bat.

The accompanying photographs were posed by Louis Pagliaro, one of the leading American players. These and the diagrams, the latter worked out with Pagliaro's assistance, should be studied carefully.

The equipment you will need, besides the




Surface must meet this bounce test

## Table

Under U.S.T.T.A. rules, the official table is nine by five feet, with its top 2½ feet above the floor. The playing surface is of dark color, with a ¾-inch white line along each edge and a ⅛-inch white line down the middle for doubles. The net is six feet long, supported by vertical posts set six inches out from the sides of the table, with its top six inches above the surface. The free space indicated around the table in the drawing is the minimum for satisfactory play. If possible, more space should be provided.

table and net, is a paddle and a ball. You probably have some rubber-soled shoes about the house and you can wear any clothing you like. Colored clothes are better. The ball is hard to see against white.

The bat and ball you must buy. The standard bat (you can call it a racket if you like) will cost as little as $1.25 and no more than $2.50. The ball, also standard, is of celluloid. The best balls cost no more than 20c each and are good for 50 to 100 games.

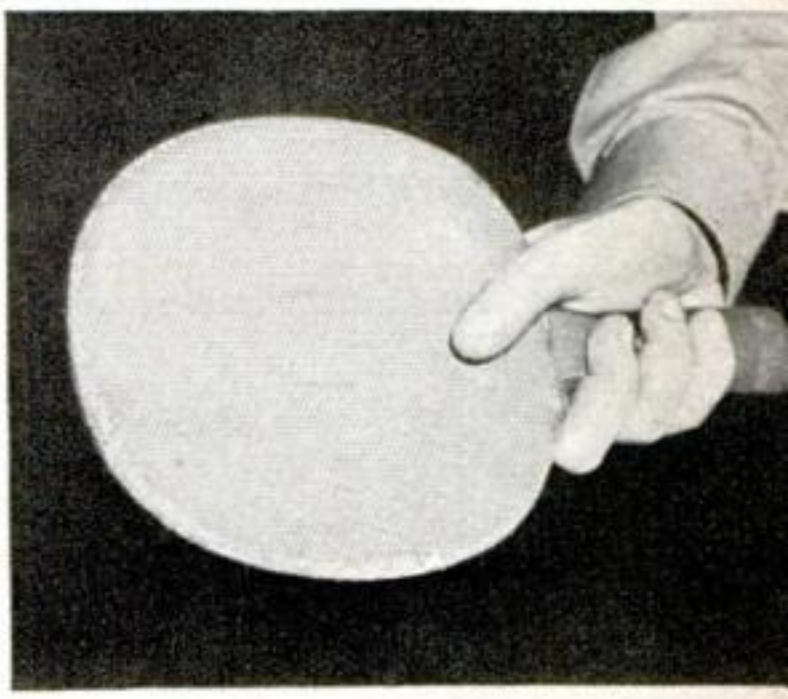
The table is more expensive if you buy one. If you desire, you can make one yourself. The cheapest regulation table costs about $20 or $25. But if you can't buy one or make one don't let that stop you. You may not have room for a regulation table, anyhow. If not, the dining-room or kitchen table will do for a starter. You can buy the net and brackets for $2.50.

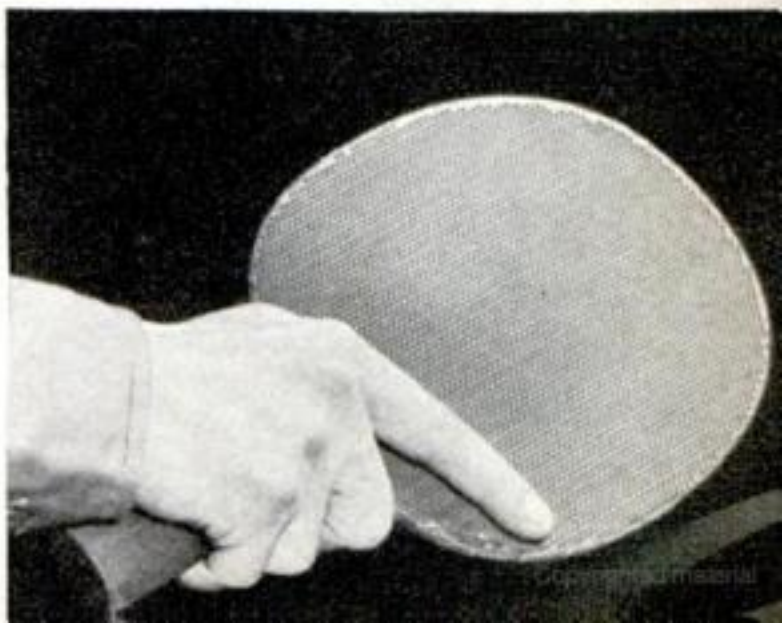
Anyone who decides to make a table, or have one built, should consult the United States Table Tennis Association, 34 South 17th Street, Philadelphia. Anyone planning to take up the game should provide himself with a copy of the Laws of Table Tennis and study them. They can be obtained from the same address.

You can set up your table in spare room, attic, basement, on the porch, in the yard or nearly anywhere. All you need is four or five feet behind each end and about three feet on either side. A single light over the center of the table will do, *(CONTINUED)*

## Grips

The so-called tennis grip, which is illustrated in two views at the right, is preferred by most professionals as an all-purpose grip. The handle of the bat is held naturally in the hand, with the thumb extended on one side of the blade and the forefinger on the other. Beginners are warned not to cultivate the old-fashioned "penholder" grip pictured in the photograph below





## Forehand Chop

Used for giving added backspin to the ball, this stroke is executed by stepping back with the right foot so that it is in line with the ball. Bend the right knee slightly and bring the bat back about half way, as shown above. The stroke is made with a downward motion of the arm, the weight shifting to the other foot. (See photo at left)

## Backhand Chop

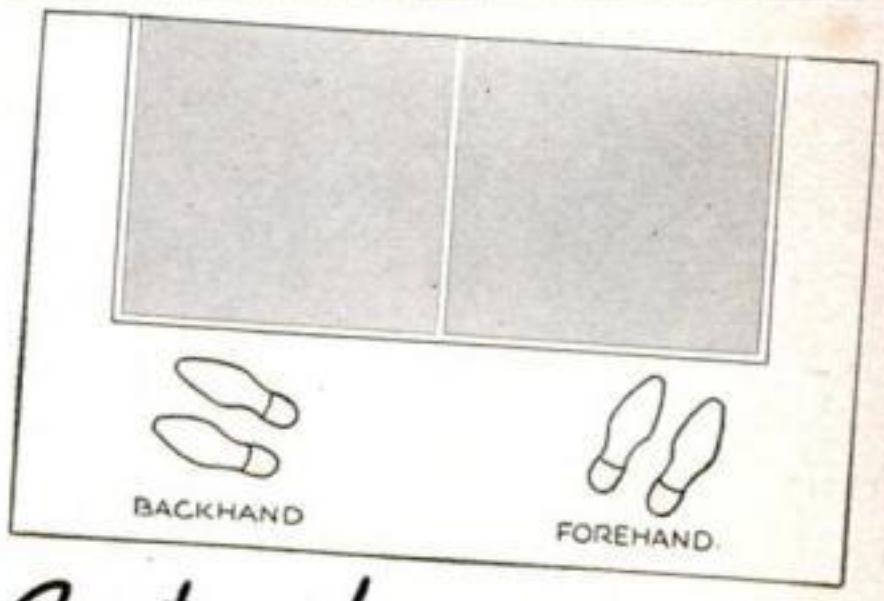
Bring the racket back to the line of the left shoulder, and bend the left knee in line with the ball. As the ball begins to drop after the bounce, swing the bat into it with a straight motion to the side and down. The offensive stroke is taken when the ball is about six inches from the racket. The successive stages are illustrated below

## Forehand Drive

In executing this drive, turn sidewise in the direction in which the ball is coming at you. The left foot is put slightly ahead of the right and you assume a half crouch with the arm bent at the elbow. As the ball bounces on the table, bring the racket back and hit the ball with a rotary motion as illustrated. The bottom surface of the bat brushes the top of the ball, giving it the top spin

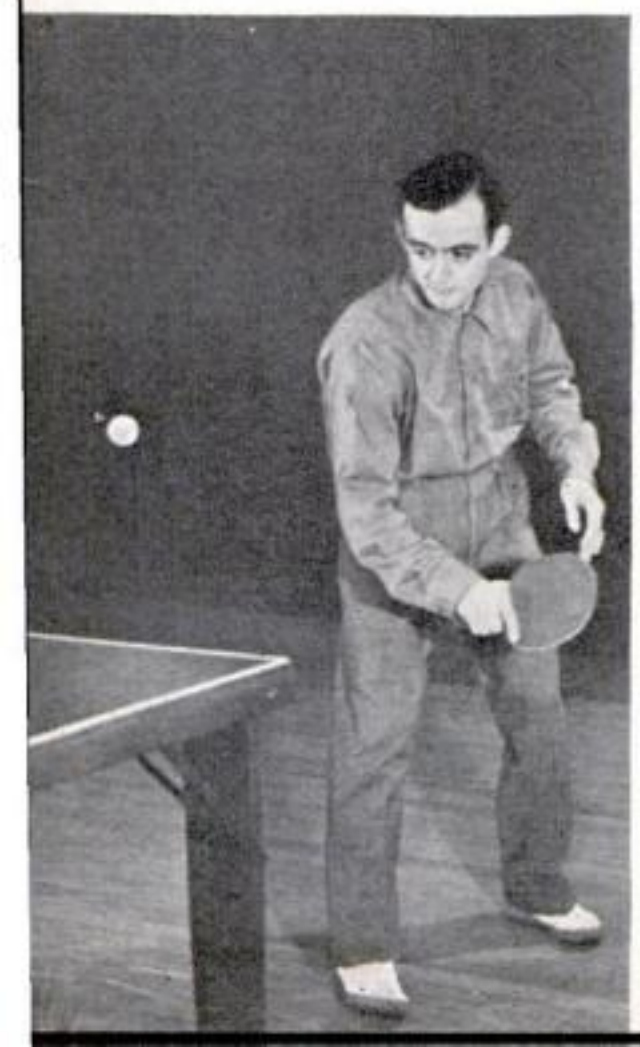
## Backhand Drive

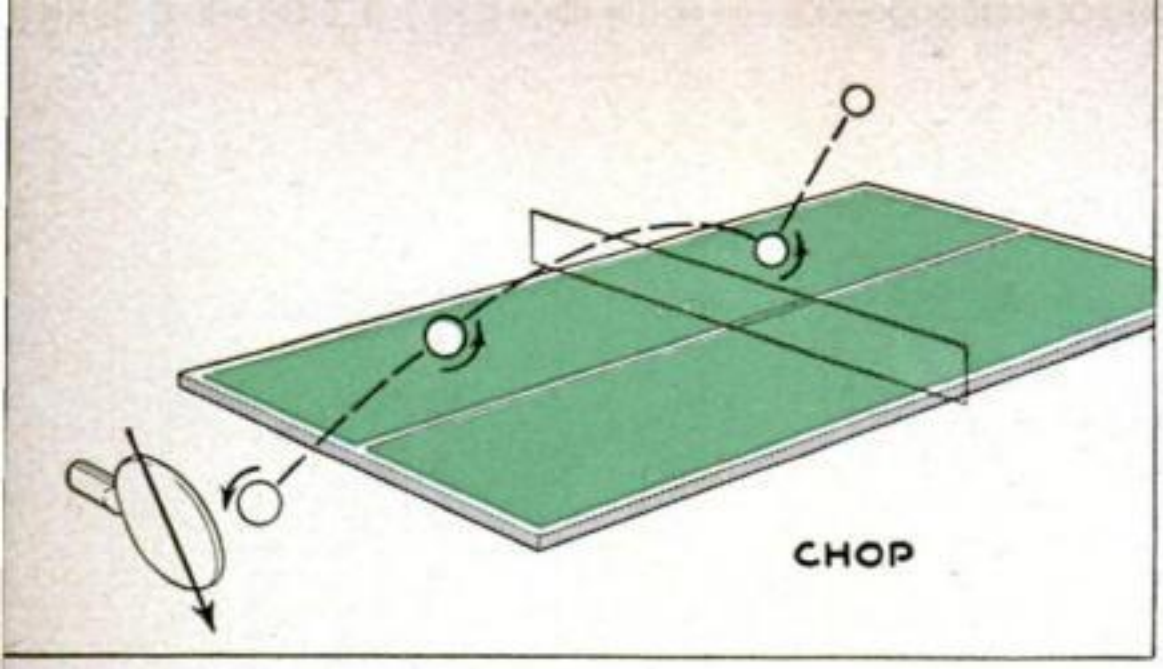
The backhand drive, illustrated below, is just the reverse of the forehand drive. This time the right foot is forward and the racket is held in front of the body as shown. By holding the racket at an angle and stroking the top of the ball, top spin is given. Beginners will work their way easily into strokes like this after mastering the simpler block shot and learning to control speed and direction

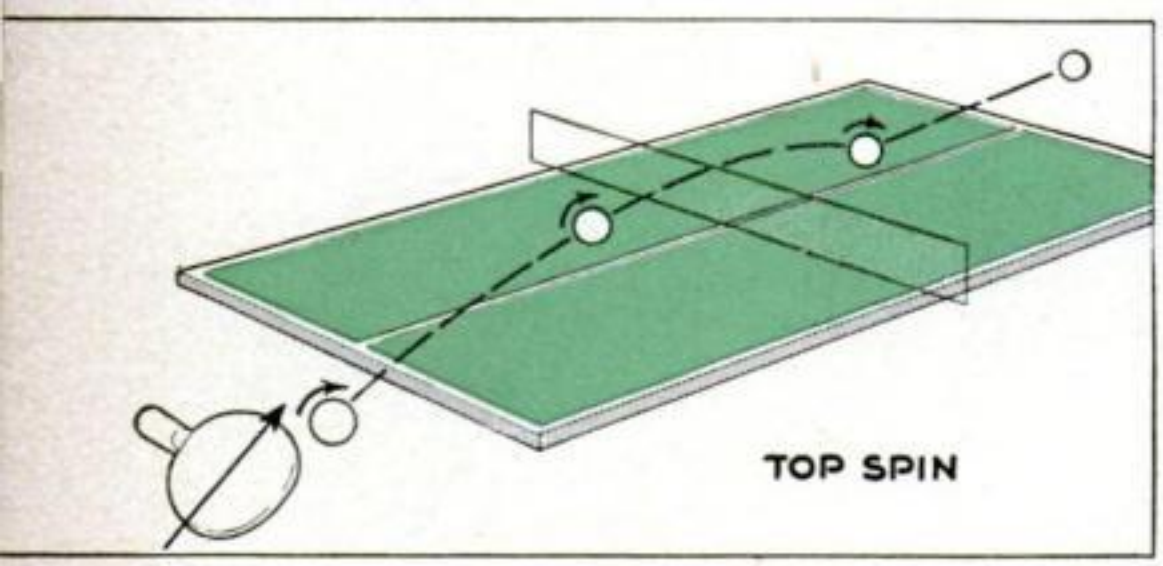


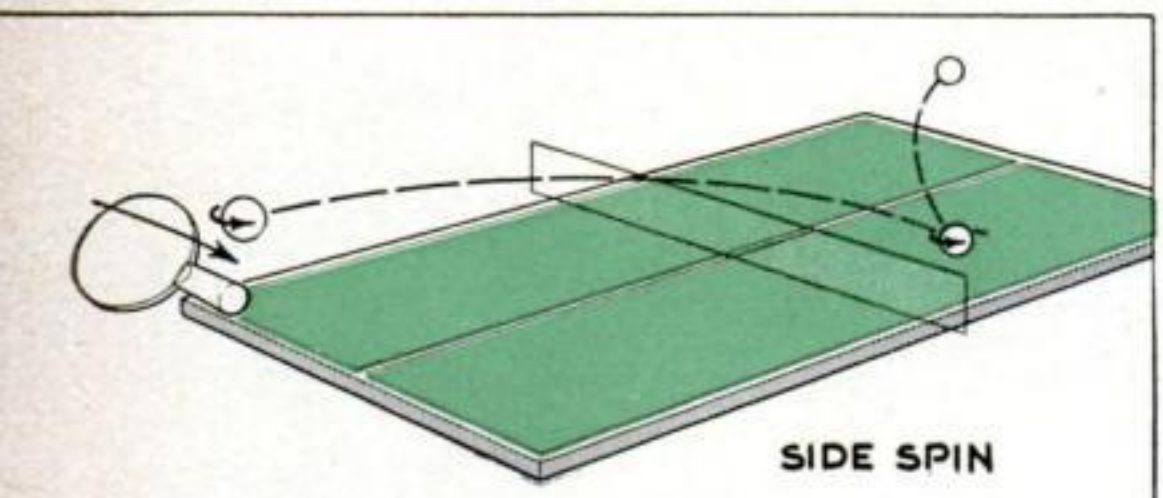

## Footwork

For backhand shots, the body is turned to the left of the ball's course, with the right foot forward. For forehand shots, the body faces right, left foot is forward






but rear lights illuminate the half of the ball the player needs to see. Three or four shaded 100-watt bulbs do nicely.

With some sort of playing surface arranged, you can begin to learn the game. First time out you are going to be awkward, but don't mind that. Coördination and timing will soon come to you.

A good grip is of great importance. Practically all the best players agree that the so-called tennis grip is best. Freakish grips are frowned upon and you are advised to avoid, as if it were the plague, the old-fashioned penholder grip. Both of these grips are illustrated. Study them.

The strokes of the game are many, but you need be concerned at first with only four —forehand, backhand, serve, and half-volley. You can quickly gain sufficient mastery over these to play a spirited game against someone not too good.

Stand a foot or so behind the middle of the table, your weight on both feet, facing the net, the bat held firmly but not tightly. First you are going to make the half-volley,

## Strokes

Here are three ways you can stroke the ball to give it spin and make it go where your opponent won't expect it. A chop stroke, with a downward motion of the bat, imparts a backspin, making the ball rotate against its direction of flight. For a topspin, the ball is stroked on top with the underside of the bat, making it roll forward as shown. The side spin, produced by a sideways motion of the bat, causes the ball to rotate in a horizontal plane, and to curve in its flight

push, or block shot. Bring the bat in front of the body about waist high, using the reverse or backhand side of the bat only.

After the ball bounces, meet it with a gentle forward push, lifting the bat slightly to make the ball clear the net, and carrying the arm forward. These two movements are executed as one. If the ball doesn't clear the net, tilt the top of the bat backward slightly. Soon you will be able to control direction somewhat and to keep the ball low. When you get the feel of it, begin trying to angle your shots.

The stroke you have now learned is a defensive shot. Now you may take up the forehand drive, the attacking shot.

For this, stand two or three feet back of the table. The stroke is made with a forward and upward motion of the arm, full but not so sweeping as the tennis stroke. You want to apply top, or overspin, which raises the ball over the net in an arc and makes it dip swiftly to the table.

At the moment of making the stroke, turn your body to the right (to the left if you are left-handed) to bring your left shoulder toward the net. Hit the ball at the highest point of its bounce and turn the body into it. The weight shifts from rear foot to forward

## Service

For the serve, the ball is held in the palm of the hand as illustrated below. Rules now forbid the old trick of holding the ball in the fingers and giving it a spin before striking it with the bat

one, which is slightly advanced. Don't reach for the ball. Make your feet place you in position. Practice by hitting the ball gently back and forth. Do not try for speed or direction until you have reasonable certainty of execution.

For the serve, the ball is dropped by hand into the air and struck with the bat so that it first touches your court and then, passing over the net, touches your opponent's court. It is difficult at first, but an adequate, if not a good serve, is soon developed. The beginner tends to serve a ball that bounces too high, but speed will come with practice.

With forehand, serve, and half-volley you can begin to play actual games with another beginner, having first learned the rules. But you should begin at the same time to master the backhand. Try to get some sort of backhand at once.

The backhand is the forehand in reverse but it is more difficult because less natural. It is a shorter stroke and the ball is hit earlier after it bounces, usually while it is rising. The stroke is forward and upward like the forehand but with more wrist action. It helps if you shift the thumb up the blade a bit for the backhand.

There are other strokes without which no player can hope to go far but they are for the future. The idea now is to begin playing and have fun right away. You have the basic strokes of the game and can play exciting games on your own level.

Later you will acquire the forehand and backhand chop, the backhand flick, the drop shot, and the smash. Do not worry about them now. If you practice well and begin to play games you will find yourself working into the other strokes. As you play you will see their possibilities and begin to exploit them. But do not take up any new stroke until the old one has been learned.

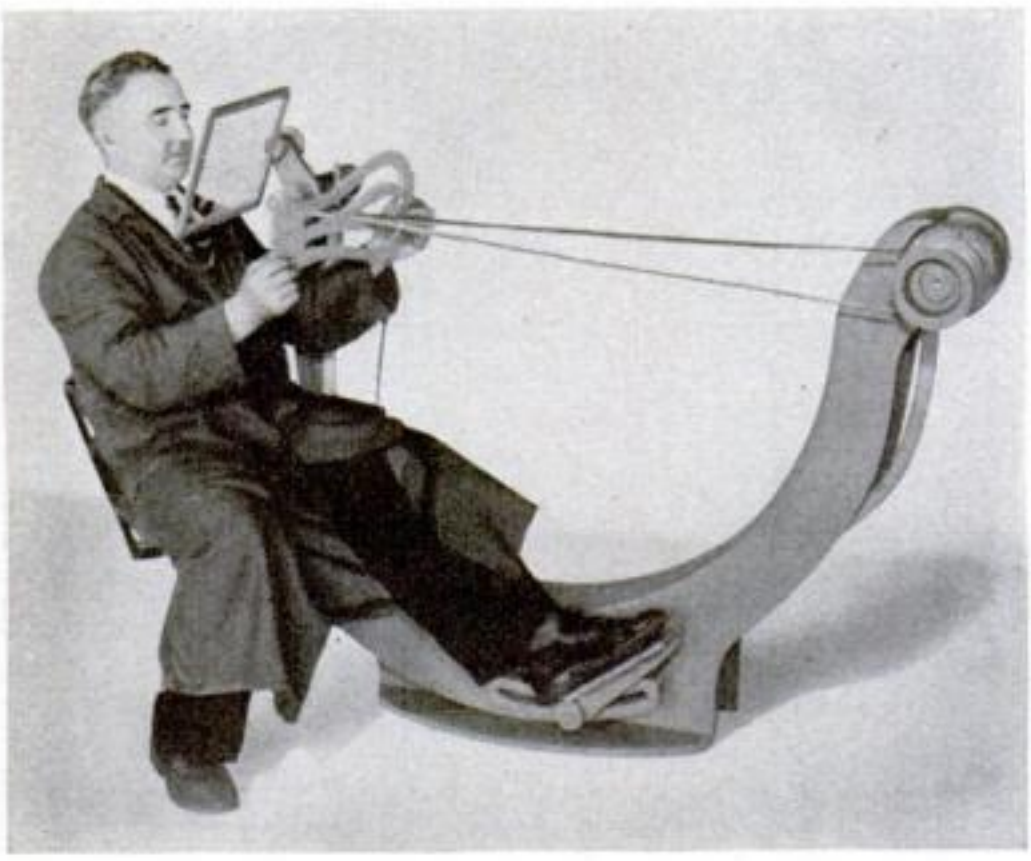
**Rescue** The rescue shot is a block shot executed at some distance back from the table. Like other defensive shots, it is made with the racket in the backhand position. Footwork is important to bring the player into just the right place for the bat to meet the ball at the right point, while still rising toward the high point of its bounce. A gentle push returns the ball across the net

By moving the hand quickly away, the ball is dropped and struck almost instantly with the racket. It must touch the server's court, pass over the net, and then touch the opponent's court. The serve shown in the pictures below and at the left is made in backhand position

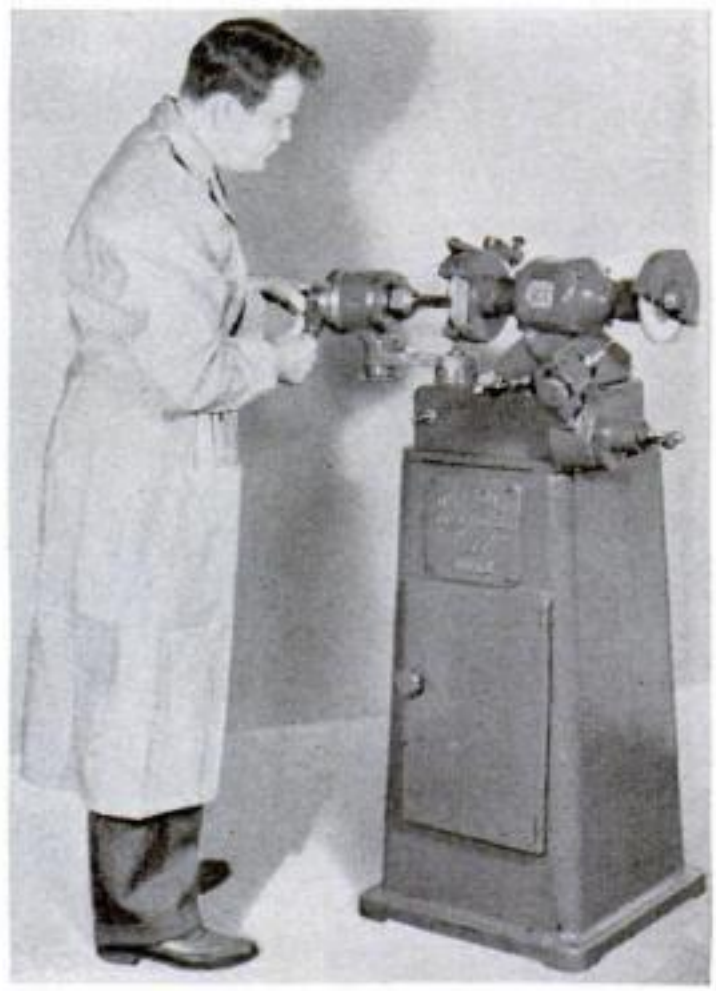
The forehand serve is made in the same way, except that the racket is brought back in the forehand position. A beginner tends to serve a ball that bounces too high and gives an alert opponent an easy chance for a smash

# new Tools

**A FLEXIBLE-SHAFT GRINDER,** in a kit that includes an assortment of mounted abrasive points, has recently been put on the market. Weighing only four and a half pounds complete, the lightweight machine can be operated on a workbench, suspended from any convenient hook, or slung from the operator's shoulder. It is said to be especially useful for any light-duty, metal-finishing job where accurate control is necessary. A pencil-size hand piece allows the operator to have full vision of his work while operating the machine, even in extremely narrow spaces.

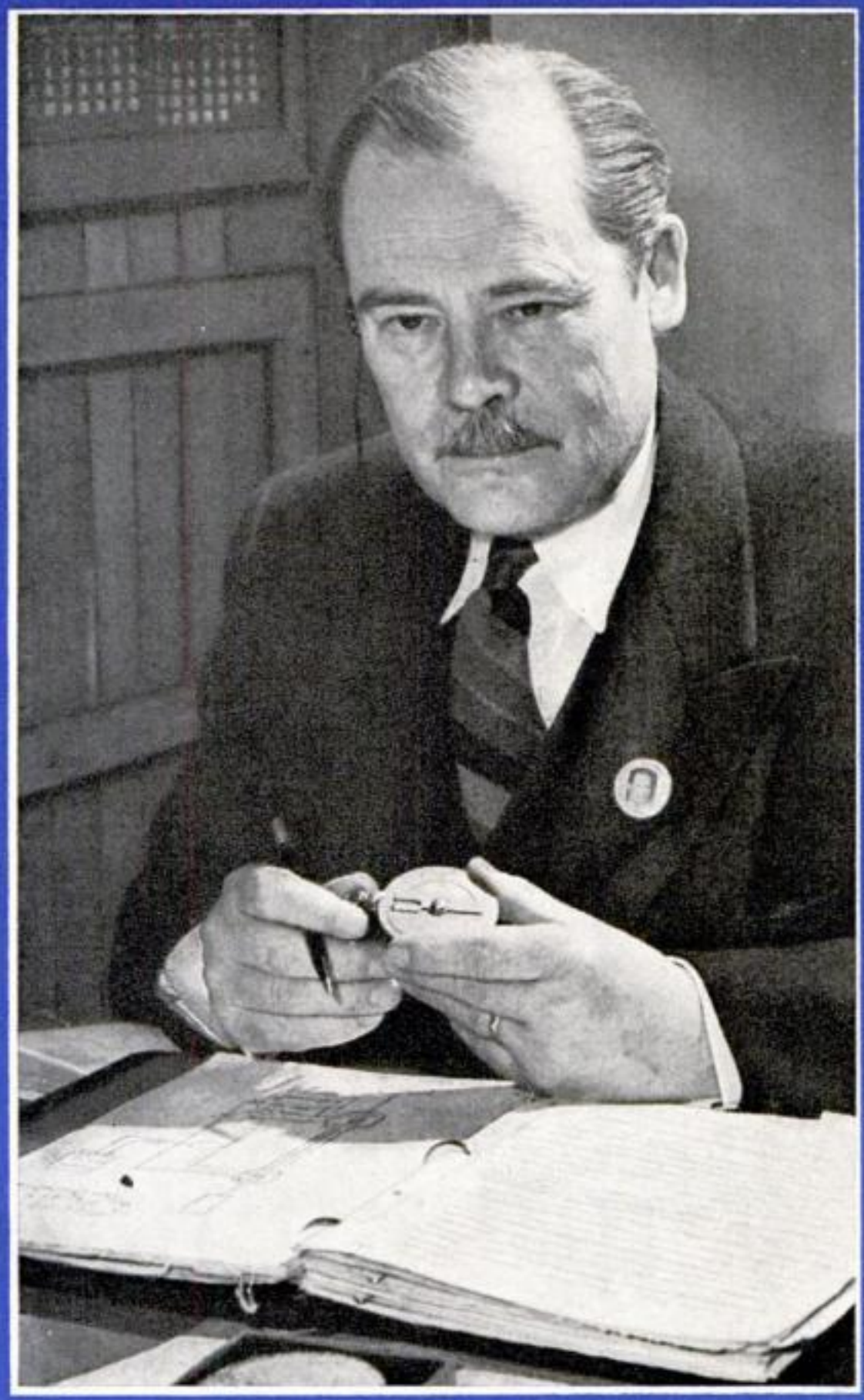


**SANDING INNER CONTOURS** of grillework can now be accomplished easily with a new machine which utilizes a thin endless belt as its sanding medium. In operation, the belt can be inserted between the grilles, attached to a pulley near the operator's seat, and spun at an even speed by an electric motor. The belt is controlled by a foot lever as shown at the left.



**A TAP RECONDITIONER** just introduced combines facilities for chamfering, spiral pointing, and point polishing in one unit. The chamfering unit, located at the left of the motor, will accommodate collets from the smallest machine-screw size up to one and a quarter inches. By means of an indexing drum, taps of from two to seven flutes may be handled. Safety stop pins limit the movement of the chamfering unit for taps with different numbers of flutes. The spiral-pointing unit, located at the right of the motor, will accommodate taps up to a half inch in diameter, using the same chuck. Correct depth and hook for spiral pointing may be obtained by vertical and horizontal feed adjustments built into the machine.

*Dr. E.W. Alexanderson helped the Allies win the First World War, with his revolutionary inventions in radio and other fields. Now he is turning his new discovery, amplidyne control, to the job of helping beat the Axis*



# Inventor for Victory

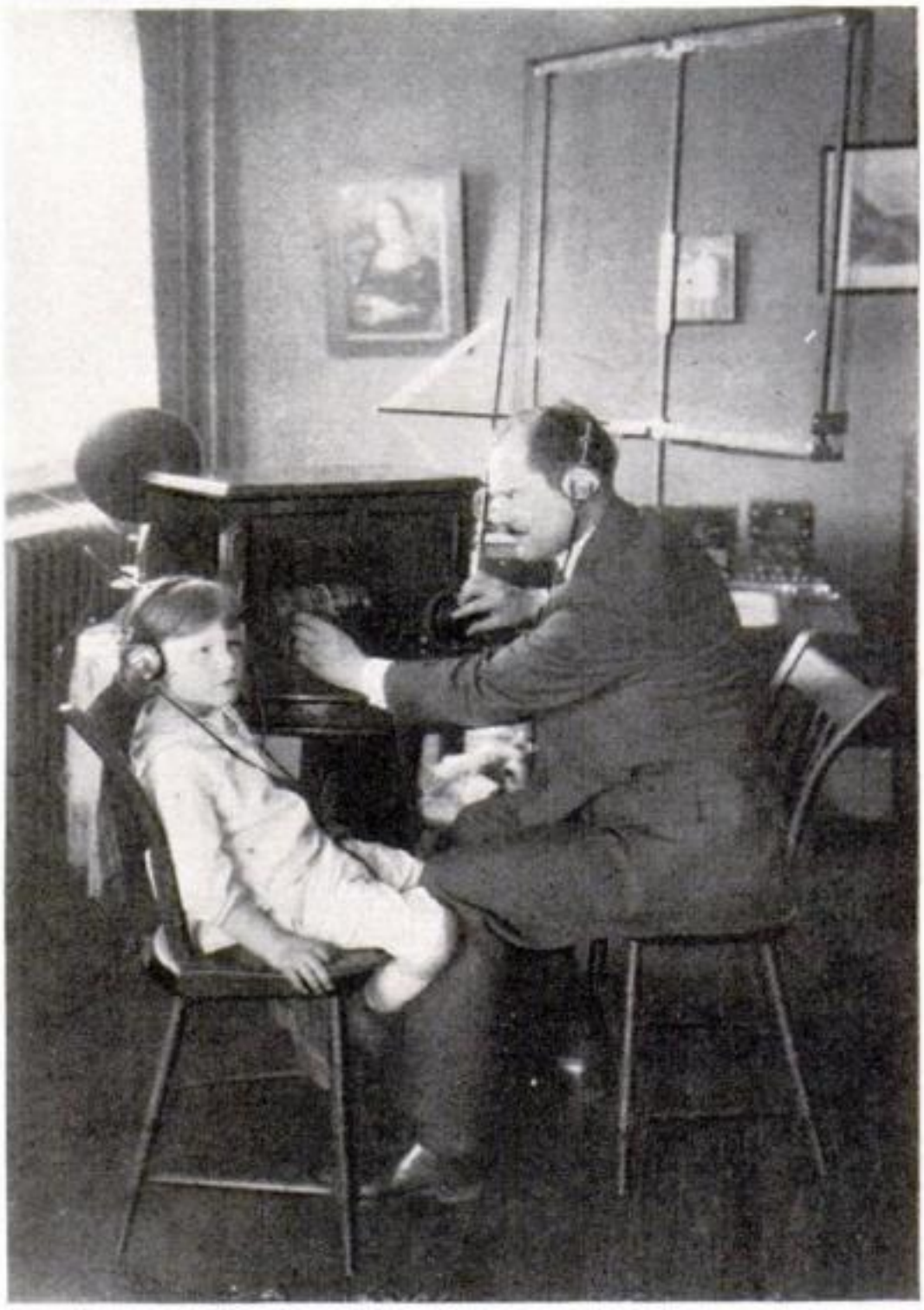
**By HERBERT ASBURY**

THE story of the American career of Dr. Ernst Fredrik Werner Alexanderson, famous consulting engineer to whom radio probably owes more than to any other man except Marconi, is not a Horatio Alger yarn of the poor boy who became rich and famous. But it is a story of democracy at its best, and its beginnings afford a striking exemplification of the democratic spirit which impelled two great and busy men to listen to a young student who came to them with no other recommendations than a thirst for knowledge and a desire to work. Dr. Alexanderson believes that a great deal of this spirit still exists in the United States, but unfortunately industries have grown so enormous that personal contacts between plant officials and workers are no longer as easy as they once were. And in his opinion that is a great pity.

"Many inventions," he said in a recent interview, "would have been lost without it. When I began to work at General Electric, I found that an unknown young engineer

Dr. Alexanderson has a fondness for keys. In his right-hand trousers pocket he carries a generous bunch including can and bottle openers and a circular slide rule which was the first thing he bought in America

Radio richly repaid the inventor's labors in 1923 when his six-year-old son Verner was kidnapped. Broadcast descriptions brought about the recovery of the boy and the arrest of the kidnappers. The photograph below, showing Verner listening to the radio with his father, was taken just three days before the boy disappeared



could walk into the office of the Chief Engineer and vice president, Mr. E. W. Rice, and tell him about his experiments."

Once when Alexanderson asked Rice to come to the laboratories and witness a test with a magnetic amplifier which he hoped would make transatlantic telephony possible, another executive said to Rice:

"Why do you waste your time on such foolish dreams, when you have so many more important things to do?"

"If this young man thinks he has discovered a way to telephone across the ocean," replied Rice, "I think it is my duty to look into it."

Rice's faith was amply justified, for Alexanderson's device made ocean telephone service possible only a few years later.

Dr. Alexanderson comes of a long line of teachers, soldiers, poets, and lawyers, many of whom have been important figures in Swedish history. His father taught for several years at the University of Uppsala, one of the cultural centers of Scandinavia, and later held the chair of classical languages at the University of Lund, where the future scientist studied for a year after graduating from the Lund High School. Because of an aptitude for mechanics, young Alexanderson entered the Royal Technical University at Stockholm, graduating as a mechanical and electrical engineer. For a year of postgraduate work he attended to the Technical University at Berlin and studied under Professor Slaby, co-creator of the once-important Slaby-Arco system of radio communication.

While in Berlin young Alexanderson read a book with the forbidding title of "Alternating Current Phenomena," by Charles P. Steinmetz, the great hunchbacked wizard of the General Electric Company, and was so impressed that he decided to go to America, where such men as Steinmetz and Thomas A. Edison were at work. In 1901 he landed

Dr. Alexanderson finds an interested audience for a new marvel. The inventor, third from left, shows a two-color disk for color television with a standard receiver. Spectators are Dr. P. C. Goldmark of CBS, General Electric Board Chairman Philip D. Reed, G. H. Payne of Federal Communications Commission

at New York, and the next day went to East Orange, N.J., hoping to catch a glimpse of Edison, but never for a moment imagining that he could actually talk to the great inventor. In the class-bound Europe with which he was familiar, such a thing would have been beyond the bounds of reason. But the gatekeeper at the Edison plant took his visit as a matter of course, and was very friendly.

"Can't get you in now," he said, "but stick around till six o'clock. The old man will be down then and you can talk to him."

And to Alexanderson's amazement, the "old man" stopped and spoke to him at length. Emboldened by his good fortune, the boy went to Schenectady a couple of months later, called at the home of Steinmetz, and was promptly admitted. He was somewhat shocked when he saw Steinmetz, but as soon as the wizard began to talk Alexanderson was no longer aware that his idol was a little hunchback, clad in a black bathing suit and crouched over a table with a huge cigar in his mouth. Steinmetz questioned the young man closely and learned of his abilities and ambitions, and a close friendship sprang up between them at once.

Alexanderson was then at work as a draftsman for the C. & C. Electrical Company in New Jersey. In February, 1902, he was hired by General Electric on Steinmetz's recommendation, and became a frequent visitor in the latter's laboratory. The next year Alexanderson took the famous G. E. test engineering course. In 1904 he became a member of the company's engineering staff, designing generators under the direction of Steinmetz. His work was brilliant from the beginning, and when he went to Sweden on a visit in 1906 Swedish industrialists urged him to stay. But his father advised him to return to America, predicting that Europe was doomed to revolution and destruction, and declaring that the new world offered the only hope for the survival of a capitalist civilization. Young Alexanderson heeded his father's counsel and upon his return to the United States immediately took out naturalization papers.

When Dr. Alexanderson first came to America radio, or wireless, was a crude business of dots and dashes transmitted by inefficient crashing sparks. If a listener

equipped with earphones managed to pick a few intelligible signals out of the jumbled air, it was a thing to be wondered at. Today you simply press a button or turn a switch, almost instantly get the particular broadcasting station you want, and listen in ease and comfort to voices and music from the distant corners of the earth. This scientific miracle, so commonplace that it arouses no more astonishment than a rainstorm, is due largely to the genius of Dr. Alexanderson, in particular to his system of tuned radio-frequency, which made possible the modern selective receiver, and to his invention employing a high-power vacuum tube for relaying and for modulation.

But Dr. Alexanderson's contributions to radio broadcasting represent only a few of his achievements; he has made vitally important discoveries and developed inventions in virtually the entire field of electricity with the exception of illumination. In addition to radio, his patents cover principally television, railway electrification, high-frequency alternators, motors, and power transmission, but in these categories they range from an electric locomotive to an amplifier, and include telephone relays, antennas, picture-transmission apparatus, synchronous and thryatron motors, and a system of electric ship propulsion. Various ways of controlling and multiplying electric power have also been devised by Dr. Alexanderson, and some of these are expected to help relieve the power shortage feared as a result of the war production program. Several of his discoveries were embodied in the electrical equipment of the aircraft carrier *Lexington* and the battleship *New Mexico*.


Radio came into its own largely as the result of Dr. Alexanderson's work during the first World War, and he may do as much this time for television, ship propulsion, power transmission, or any of a dozen related fields in which he holds 289 patents, granted to him since 1905 at the rate of one about every seven weeks. Incidentally, Dr. Alexanderson looks upon war not as a spur to invention, as it is popularly supposed to be, but as a period of urgent necessity which provides both incentive and opportunity for the application of principles already known and the development of devices already in the inventor's mind. That is what he did in the first World War, and what he and other scientists are doing now.

Dr. Alexanderson's first real opportunity in America came when Professor Reginald A. Fessenden, a pioneer radio experimenter, asked the General Electric Company to build a high-frequency alternator of 100,000 cycles. Since no generator had yet been built to operate at frequencies above a few thousand cycles, the idea was considered fantastic by every one save Fessenden, Steinmetz, and Alexanderson, to whom Steinmetz turned over the job without comment. After two years of hard work, during which time several experimental models were constructed and discarded, Alexanderson produced a practical alternator of 50,000 cycles, which was installed in Fessenden's broadcasting station at Brant Rock, Mass. With it Professor Fessenden was able, on Christmas Eve of 1906, to put the human voice on the air for the first time in history. It was this machine, the famous Alexanderson alternator, that assured reliable transatlantic radio communication.

Other important inventions developed by Dr. Alexanderson during the war included the multiple-tuned antenna, the antistatic receiver, and the magnetic amplifier. The amplifier had established the practicability of transatlantic telephony as early as 1915, but it attracted little attention until February 22, 1919, when the Alexanderson high-frequency alternator, magnetic amplifier, and multiple-tuning system made possible the first two-way conversation, between the station at New Brunswick and the steamship *George Washington*, 900 miles at sea, carrying President Wilson to the Peace Conference. Dr. Alexanderson's discoveries in radio paid him an unexpected dividend in 1923, when broadcast descriptions of his kidnapped six-year-old son were instrumental in recovering the boy.

Since the World War, discoveries and inventions have come from Dr. Alexanderson's laboratory with extraordinary rapidity. The patents describing his various devices and systems fill several large volumes in the General Electric library, and just to list them would require many pages of POPULAR SCIENCE MONTHLY. A few, however, should be mentioned, among them the electronic amplifier, the directional transmitting antenna, radio altimeters, studies in the polarization of radio waves which made possible effective radio direction finders, and a tuned radio-frequency system which provided selective tuning.

Dr. Alexanderson also did much notable pioneer work in television and in the transmission of pictures by radio. On June 5, 1924, he transmitted *(Continued on page 204)*

# Un-Natural History

BY *Gus Mager*

THE **RACQUET-TAILED MOTH**, FOUND IN AUSTRALIA AND NEW GUINEA, HAS SUCH LONG STREAMERS ON ITS POSTERIOR WINGS THAT THE CREATURE IS SAID SOMETIMES TO MEASURE AS LONG AS TEN INCHES!

SCRIPTURAL REFERENCES TO THE **HIPPOPOTAMUS** AS THE BLOOD-SWEATING BEHEMOTH HAVE RECENTLY BEEN INVESTIGATED BY NATURALISTS. THEY REPORT THAT THESE AFRICAN GIANTS SOMETIMES REALLY PERSPIRE A RED FLUID WHICH RESEMBLES BLOOD!

WALLING UP HIS MATE IN A TREE HOLLOW DURING THE INCUBATION PERIOD IS THE **HORNBILL'S** METHOD OF MAKING SURE THE EGGS ARE PROPERLY HATCHED! HE ALSO SPORTS A REAL PAIR OF EYELASHES!

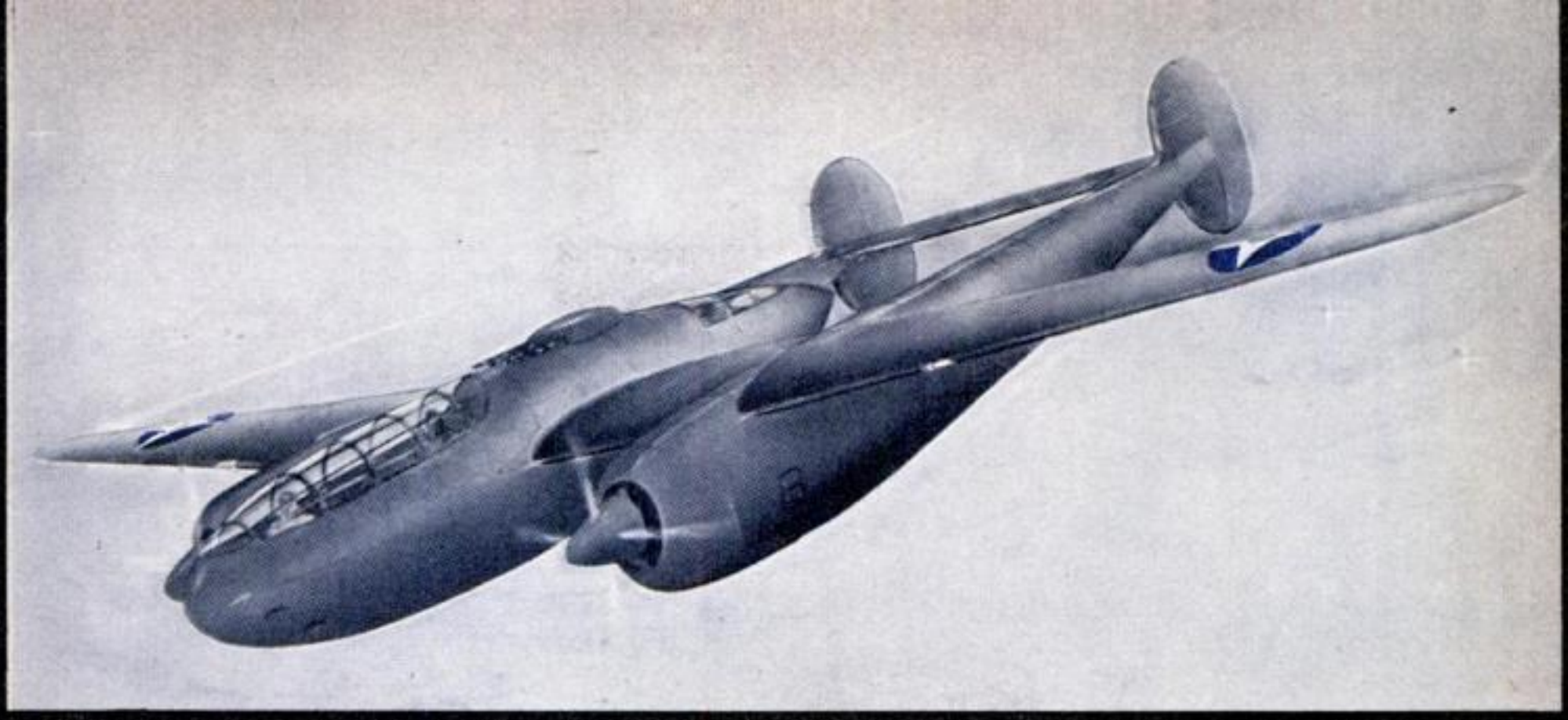
THE **CORK OAK** REQUIRES **50** YEARS' TRAINING BEFORE IT CAN PRODUCE THE BEST-GRADE BOTTLE CORKS! THE VIRGIN BARK, STRIPPED WHEN THE TREE IS **20** YEARS OLD, IS OF POOR QUALITY AND USED ONLY FOR COARSE PURPOSES! BARK IS SUBSEQUENTLY STRIPPED EVERY TEN YEARS, YIELDING A BETTER GRADE OF CORK WITH EACH CUTTING!

WHEN A **MARINE CONCH** IS PLACED ON DRY LAND AWAY FROM THE WATER, IT WILL ACTUALLY JUMP BACK TO ITS NATURAL ELEMENT! THE CONCH WILL BRACE ON THE CLAW OF ITS FOOT AND, HOP BY HOP, WORK ITS WAY BACK INTO THE WATER!

**PARROT FISH** HAVE SUCH STRONG FRONT TEETH THAT THEY OFTEN SCRATCH THE GLASS SIDES OF AQUARIUM TANKS! THESE TEETH, RESEMBLING A PARROT'S BEAK, ARE USED TO SCRAPE OFF PARTS OF CORAL STALKS IN THEIR NATURAL HABITAT!

A FOUR-ENGINE BOMBER of the future conceived by design engineers of the U. S. Army Air Corps' Aircraft Laboratory at Wright Field, Dayton, Ohio, gains added fire power by using pusher-type propellers on its outer engines, leaving the front ends of the nacelles clear for guns

"THE BAT" suggests the experimental "flying wing." Its single engine, driving contra-rotating pusher propellers, is submerged in the enlarged center of the wing, which also accommodates the cockpit. Twin booms support the broad tail assembly

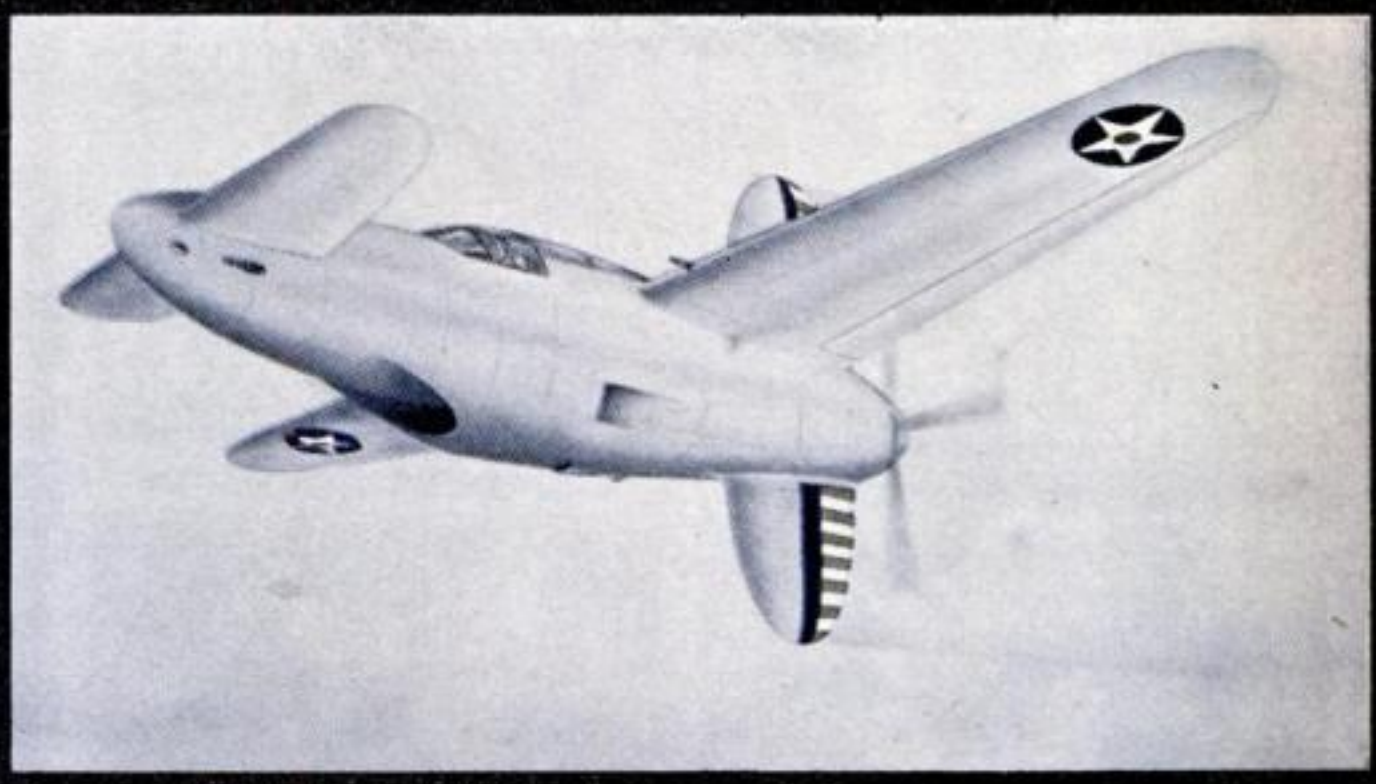


"THE SHRIKE" gets concentrated fire fore and aft, with a design somewhat like that of the P-38 of today

# The Air Corps Looks Ahead

WITHIN the Army Air Corps Materiel Division at Wright Field, Dayton, Ohio, a group of young Air Corps officers and civilian engineers are designing planes of greater speed, power, and maneuverability than any we have today. Although dubbed the "Buck Rogers Department," these men base their radical designs on actual experience in aeronautics. Most noticeable in this Design and Development Unit is the trend toward pusher-type planes, said to have a greater speed of climb.

"THE CANARD" (at right) seems to be flying backward, as its tail is in front and its propeller at the rear. This novel arrangement is said to eliminate rough air above the plane, and to give the pilot excellent vision





"THE SNIPE" (at left) has its single engine completely submerged in the fuselage behind the pilot, driving contra-rotating twin pusher propellers. Vision characteristics are specially good in this pursuit ship. All these designs represent trends being explored at the Dayton laboratory, many of them paralleling similar developments in Europe

# Here's My Story

DR. CHARLES·M. SLACK, RESEARCH PHYSICIST FOR WESTINGHOUSE ELECTRIC, WAS BORN IN

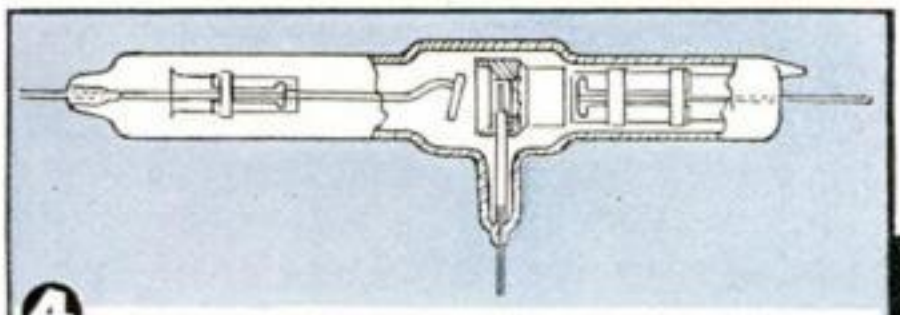
1 AN AUTHORITY ON HIGH-SPEED X-RAY PHOTOGRAPHY, HE HAS RECENTLY PERFECTED FOR THE ARMY A MACHINE THAT CAN MAKE TWO SEPARATE EXPOSURES ON FILM DURING THE PASSAGE OF A SINGLE BULLET THROUGH ARMOR PLATE

2 YOUNG SLACK MAJORED IN PHYSICS AT THE UNIVERSITY OF GEORGIA AND WAS AWARDED HIS DOCTORATE AT COLUMBIA IN 1926. HE WAS A TENNIS CHAMPION AT COLLEGE

3 ON THE MERIT OF HIS WORK ON X RAYS DURING COLLEGE, HE WAS GIVEN A JOB AT WESTINGHOUSE DOING RESEARCH WORK IN THEIR X-RAY DEPARTMENT. TWELVE YEARS LATER, HE READ THAT HIGH-SPEED X-RAY PICTURES HAD BEEN MADE IN EUROPE BY MEANS OF A TUBE THAT USED A POOL OF MERCURY INSTEAD OF A FILAMENT. HE CONSTRUCTED A SIMILAR TUBE BUT IT PROVED UNSATISFACTORY

# THE CAREER OF
# DR. CHARLES M. SLACK

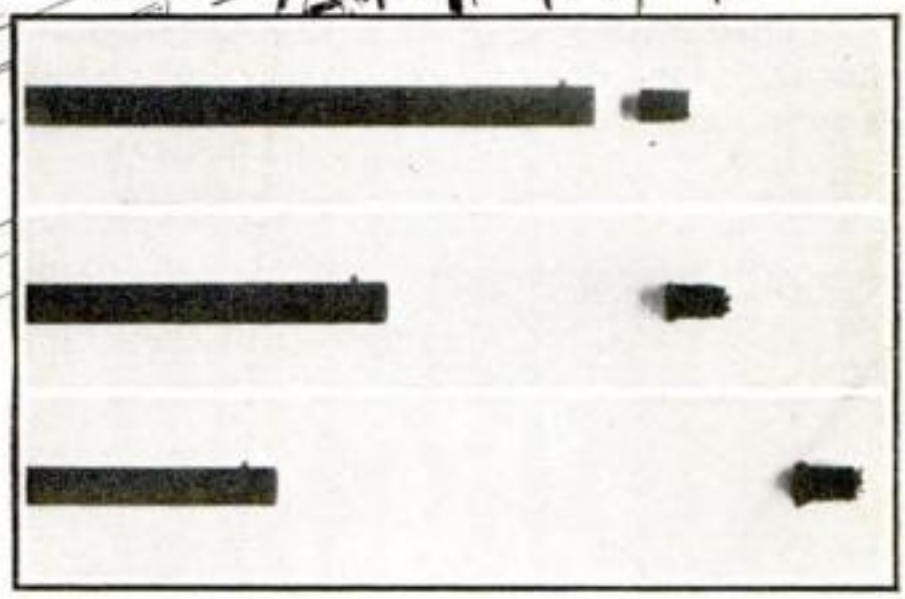
MARIETTA, OHIO, ON DECEMBER 4, 1901



4 AFTER SEVERAL EXPERIMENTS, HE CONSTRUCTED A THREE-ELEMENT TUBE CONSISTING OF AN ANODE AND CATHODE WITH AN ADDED TRIGGER ELECTRODE TO START THE ELECTRONIC DISCHARGE

5 BY APPLYING 1,000,000 VOLTS FROM TWO CONDENSERS, THE ELECTRONS WERE LITERALLY YANKED OUT OF THE CATHODE TO FURNISH ENOUGH X RAYS IN A SPLIT SECOND TO MAKE A PICTURE. THIS PREVENTED FLASHES WHICH PREVIOUSLY HAD SPOILED THE TUBE'S EFFICIENCY

B.W. SCHLATTER



6 ON MARCH 4, 1940, DR. SLACK MADE HIS FIRST 1/1,000,000-SECOND PICTURE WITH THE NEW TUBE. IT SHOWED A .22 CALIBER BULLET STOPPED IN MID-AIR AS IT LEFT THE GUN MUZZLE. SINCE THAT TIME, HE AND HIS ASSISTANTS HAVE MADE HUNDREDS OF OTHER ACTION PICTURES. THE X-RAY AT THE LOWER RIGHT SHOWS WHAT HAPPENS WHEN A FOOTBALL IS KICKED

# BATTLE-LINE REPAIRS

## *Keep Damaged Ships Fighting*

SOMEWHERE in the Pacific, not long ago, a Japanese air bomb crashed through the deck of an American aircraft carrier and exploded. Tokyo dispatches reported the vessel crippled, or sunk, according to the extent of their optimism. Actually the ship remained in successful action, while a few skilled artisans made short work of eliminating the bomb hole and straightening twisted piping.

Today, every major warcraft carries a damage-control crew, specially trained to put out fires, mend broken mains, and keep the hull water-tight during combat. Upon their success in coping with all conceivable emergencies depends the commander's ability to fight the ship until the engagement is won, and there is time to supplement in port the "first-aid" measures taken in the heat of battle.

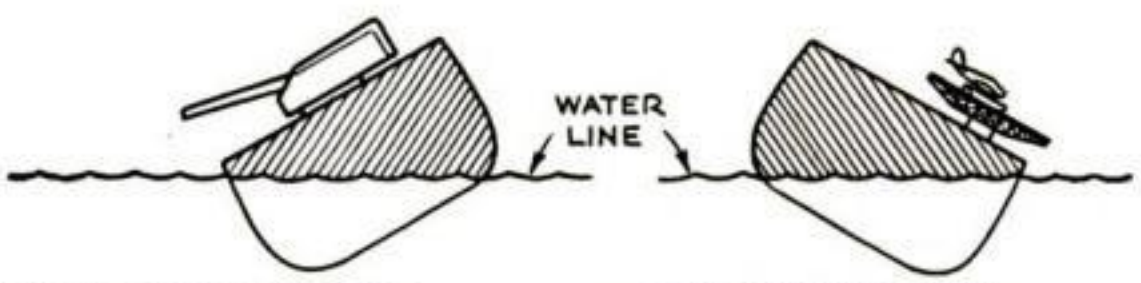
Even though water-tight compartments keep a man-of-war afloat, underwater hull damage by a torpedo, a shell, or an air bomb's "near miss" can put it out of action as effectively as if it had been sunk. Sketches below show some of the reasons.

Therefore urgency usually takes precedence over seamanship in righting the vessel. "Counter-flooding" offers a quick way. Remote-controlled sea valves, supplemented if necessary by fire hoses dropped through manholes, inundate compartments at the opposite side and end of the ship from the damage-flooded ones. This remedies list, and restores fore-and-aft trim—although at the expense of increased draft, with some loss of speed and stability. Alternatively, large "equalizing pipes" may allow water to flow from a damaged compartment into the corresponding one on the opposite side of the ship. This levels the vessel laterally, but not fore and aft.

When time permits, a damaged ship may be trimmed by shifting heavy weights, such as ammunition or fuel. If the leak is small, pumps may be able to handle it—sometimes with the aid of a collision mat of reinforced canvas, hauled down over the hole by a rope or chain passed beneath the keel. Or, if the hole is near the bottom of the compartment, compressed air will force and hold the water out.

Fire started by shells or bombs means the end of the ship if it reaches the magazines. At all costs, damage-control parties must brave an inferno below decks to keep flames from danger points. One deadly path for fire leads from shell-penetrated turrets to magazines by way of ammunition hoists and powder-handling rooms, as the British learned from bitter experience at Jutland. Modern ships meet the menace with *(CONTINUED)*

**WHY WARSHIPS IN BATTLE MUST MAINTAIN AN EVEN KEEL, AND**

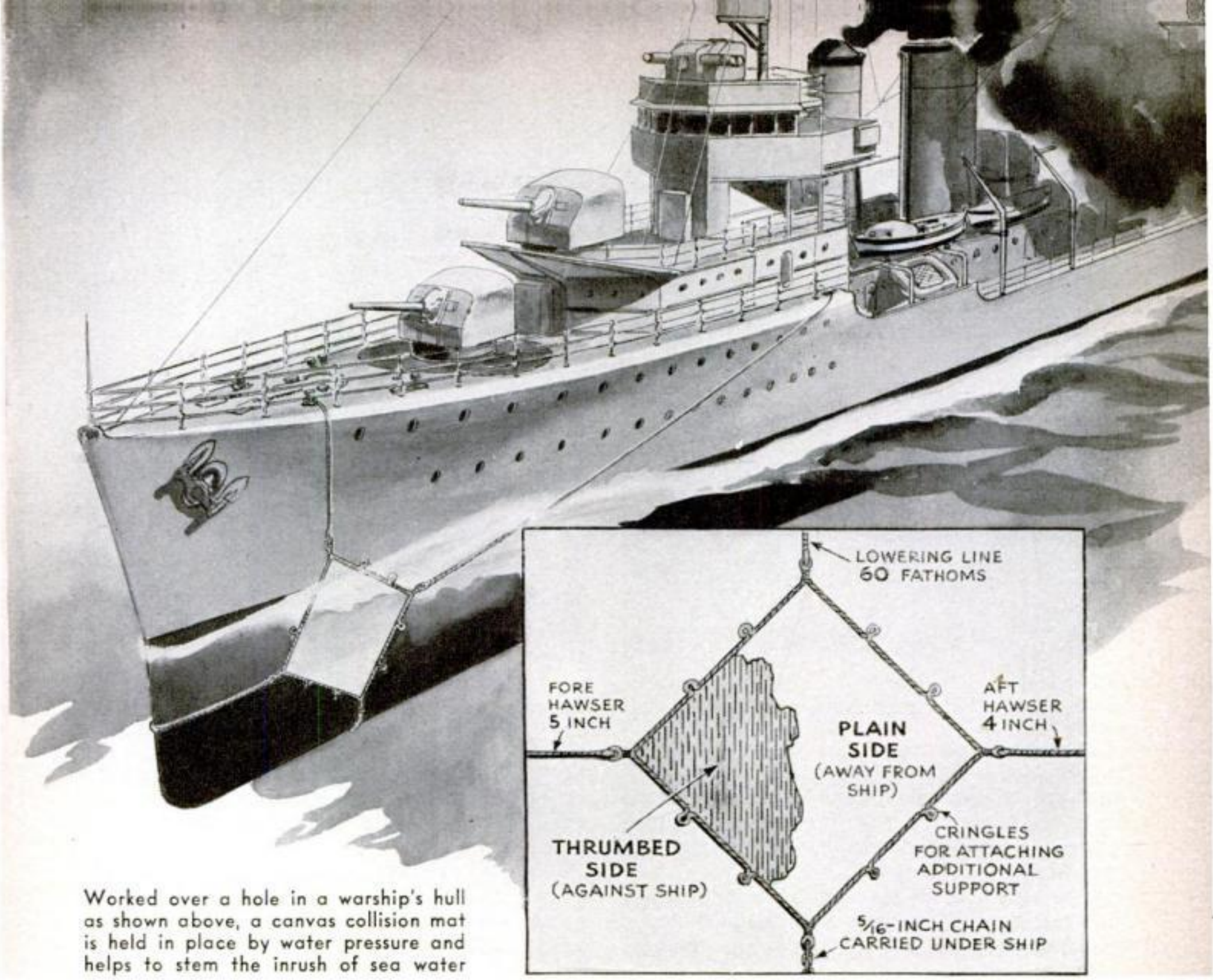



LIST LOWERS GUNS TOO FAR TO BE TRAINED ON ENEMY···

···AND INTERFERES WITH LAUNCHING CATAPULT PLANES

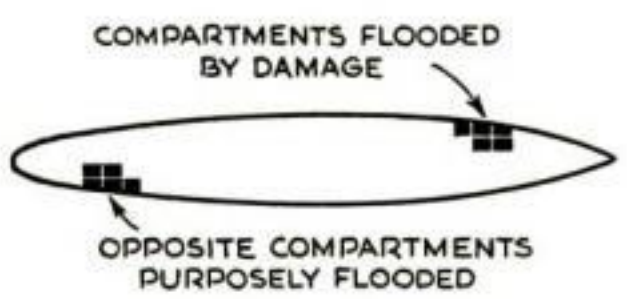
MEN CANNOT WORK EFFICIENTLY ON TILTED DECKS AND PLATFORMS

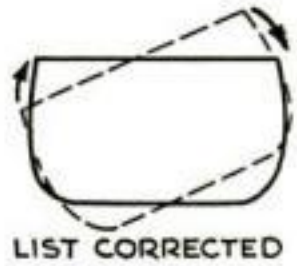
SEAS BREAKING OVER DECKS MAY PUT TURRETS AND OTHER BATTLE STATIONS OUT OF COMMISSION, AND FLOOD MAGAZINES. PROPELLERS NEARLY OUT OF WATER LOSE EFFICIENCY




Worked over a hole in a warship's hull as shown above, a canvas collision mat is held in place by water pressure and helps to stem the inrush of sea water

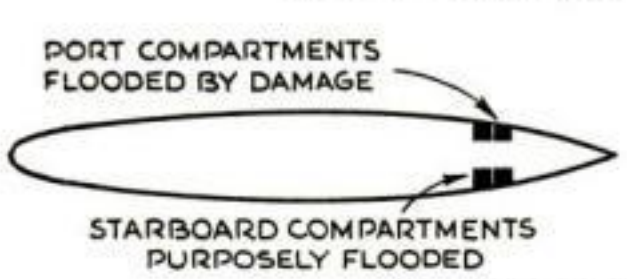
## HOW DAMAGE-CONTROL CREWS DO THE JOB BY COUNTER-FLOODING

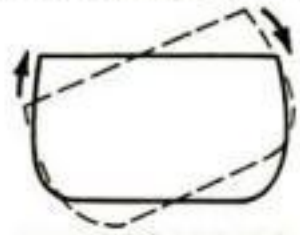




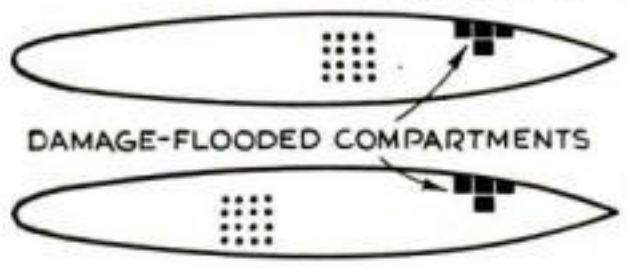
**COUNTER-FLOODING METHOD OF RIGHTING DAMAGED SHIP** (PREFERRED)



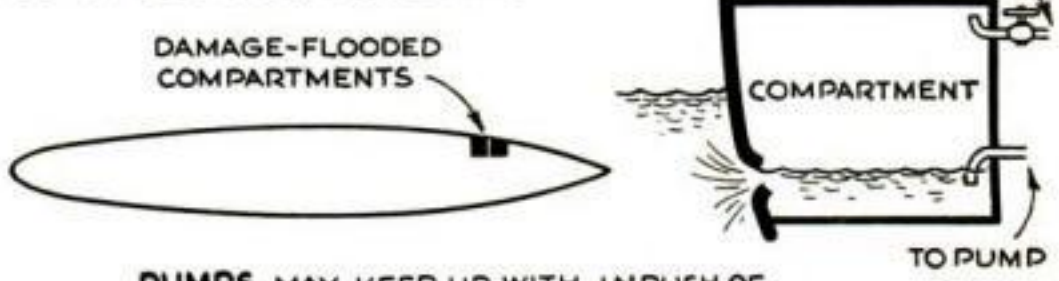





**ALTERNATE METHOD OF COUNTER-FLOODING**




**SHIFTING WEIGHTS,** SUCH AS AMMUNITION, CORRECTS LIST AND FORE-AND-AFT TRIM



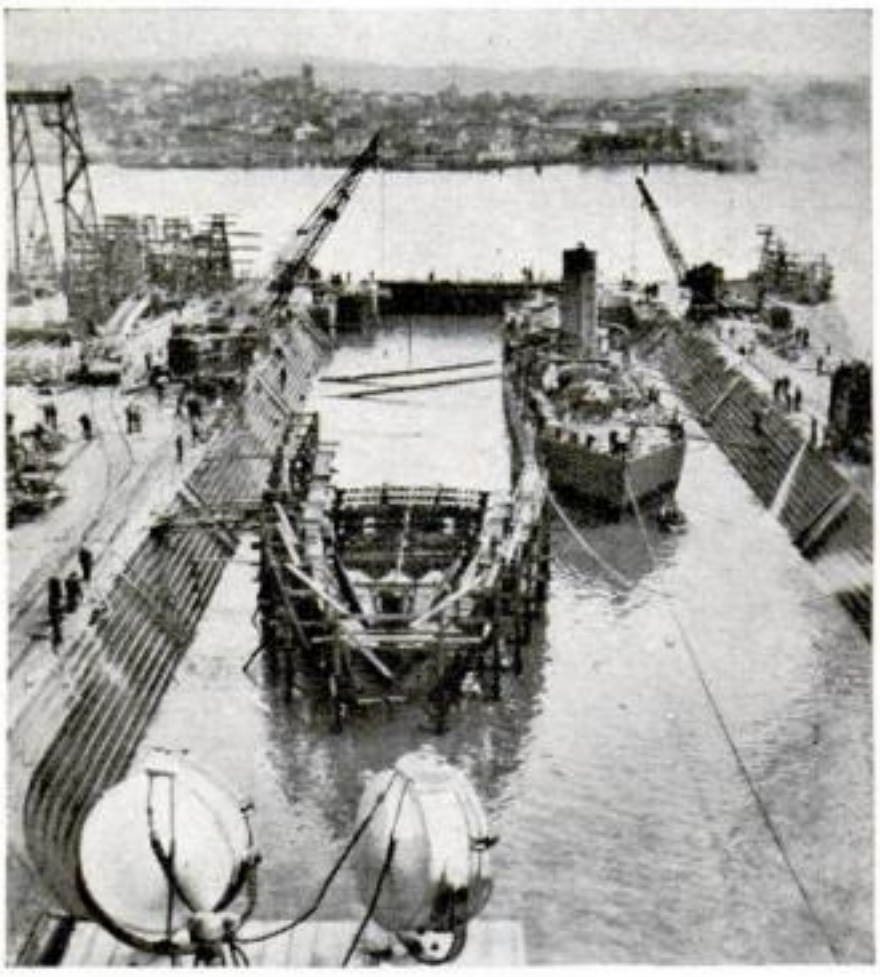

**PUMPS** MAY KEEP UP WITH INRUSH OF WATER IF HOLE IS SMALL. **AIR PRESSURE** EMPTIES FLOODED COMPARTMENT AND KEEPS IT DRY IF HOLE IS NEAR BOTTOM

A gaping hole in the deck of a U. S. Navy vessel shows where a Japanese aerial bomb found its mark

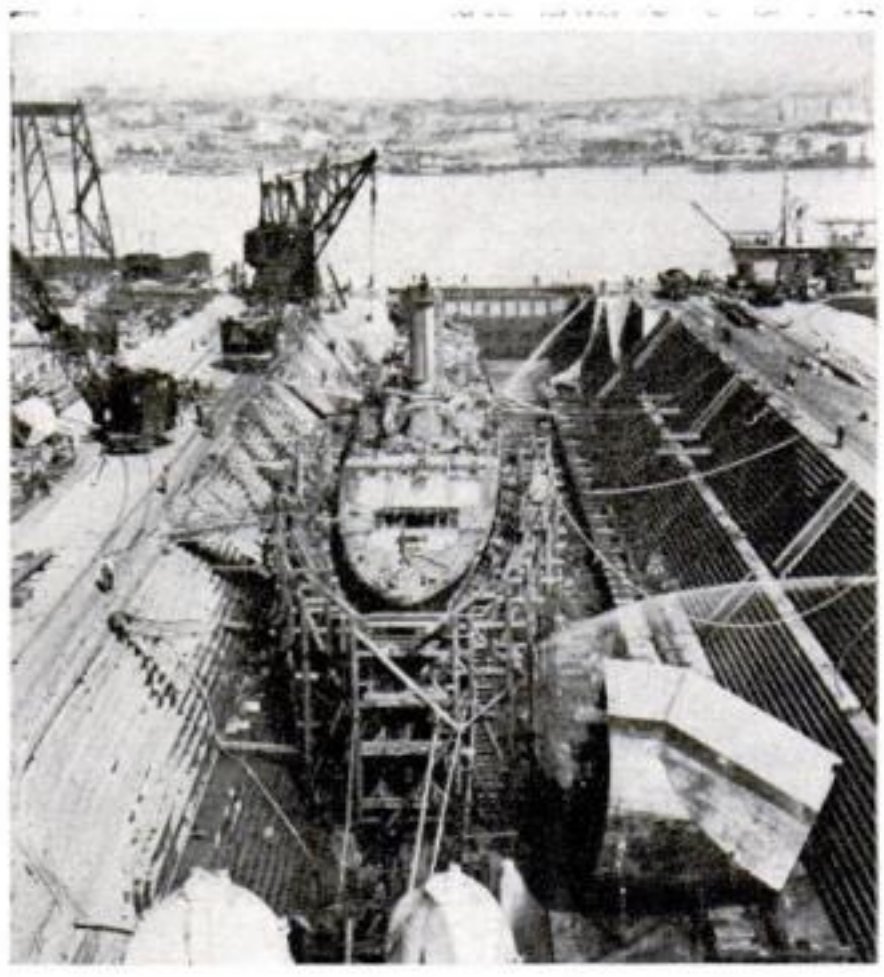
. . . and this is how it looked after the trained damage-control crew had finished temporary repairs

flameproof scuttles for passing powder bags through a magazine door without opening it, and by keeping handling spaces clear of ammunition not intended for immediate use.

When the big battle wagons, punch-drunk and reeling under seemingly knockout blows, continue to slug it out, it may be because damage-control crews rush into action to keep a toppling mast from fouling a whole group of turrets. If steering engines are smashed, they make repairs or fit jury rigs in time for the vessel to regain its place in the battle line. Pitted against every weapon that can be devised to batter a ship to pieces, they perform near-miracles to patch it together while it is under fire, and keep it in the fight.



Reported sunk at Pearl Harbor, the destroyer Shaw is seen above in a West Coast drydock where a new nose is waiting to replace a makeshift repair job

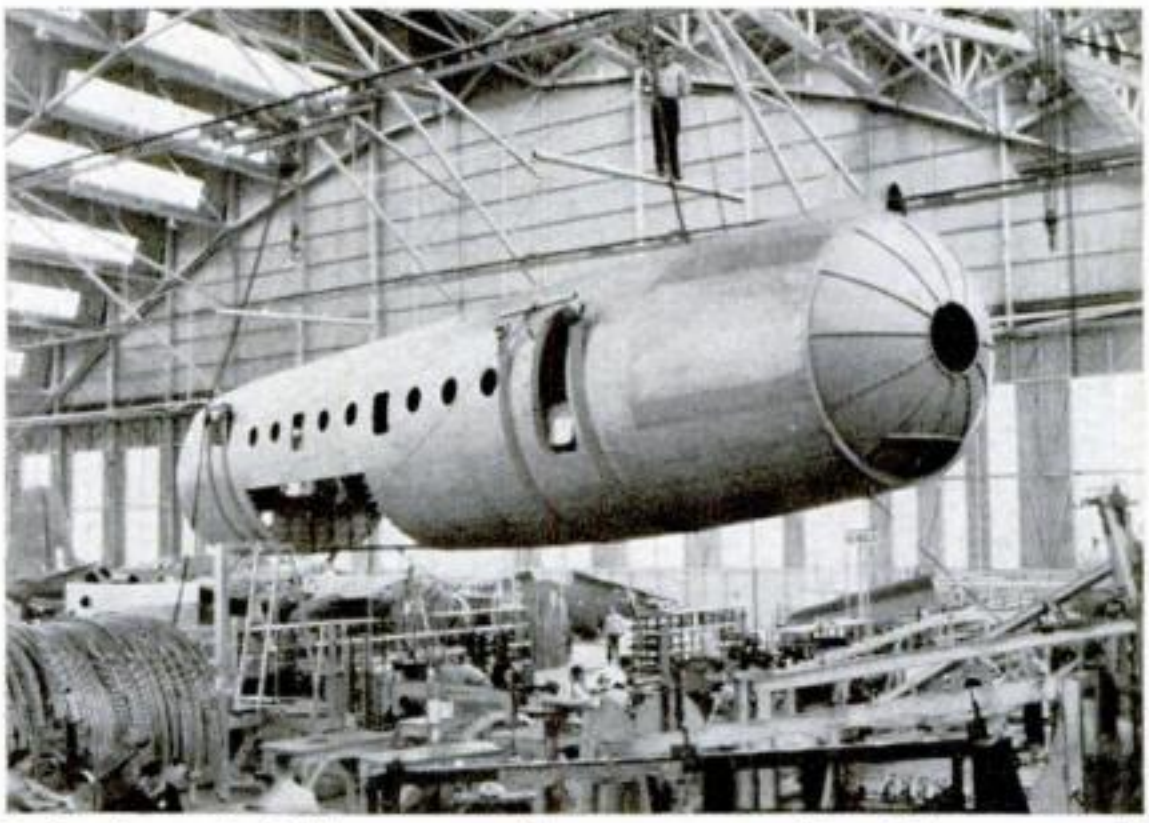


Joined to a brand-new bow, the Shaw is a whole ship again. The temporary nose (at right) which brought her across from Hawaii will be turned in for scrap

# Substratosphere Army Transport Carries 50 Soldiers

The new Douglas C-54 taking off. Note double landing wheels, safety measure against tire or brake failure

LARGEST of Army transport planes, the new Douglas C-54 is equipped with a pressurized cabin for carrying 50 armed soldiers safely through the substratosphere. The new transport is powered by four 1,350-horsepower air-cooled engines. Its tricycle landing gear is fully retractable and the main wheels are in pairs as an added safety measure in case of a blowout, or brake failure. Although no specific details about the plane can be revealed, military experts declare the plane has a longer range and is faster than any other large military transport plane in the world.



Out of a giant jig comes the pressure cabin, big as a railroad car. Hemispherical end distributes air-pressure load evenly

# Direct Bullet Hits Will Not Shatter New Oxygen Tank for Flyers

SHATTERPROOF oxygen tanks have been developed to protect the lives of combat flyers in oxygen-equipped planes. Previous to the development of the new tanks, warplanes had high-compression oxygen cylinders of brittle steel. When hit by a projectile, such a cylinder would explode and small jagged bits of metal would fly through the plane, often causing the death of the pilot or one of the crew. The new shatterproof cylinder, made of tough but soft metal, will not burst even when riddled with .50 caliber machine-gun bullets. At top, left, is one of the new tanks that has been punctured by a bullet, contrasted with one of the earlier type that has shattered into fragments.

# PRECISION BOMBING TAKES Teamwork

By HICKMAN POWELL

WHEN you hear the men on the far battle fronts calling for planes and more planes, just remember that what they really are asking for is combat teams and more teams—equipped with fighting airplanes, of course.

The efficient operation of a bombardment airplane involves one of the most intimate mergers of personality ever attempted or achieved by seven, eight, or nine aggressive, hard-hitting, individualistic American youngsters. This suppression of ego and merger of fighting men into a single combat organism is so basic and well understood by military flyers that they hardly even mention it when they call for "planes." But its necessity should be understood by us laymen, too, lest we jump too easily to the conclusion that bombers are ready for aggressive action as soon as they roll off the assembly lines.

This sobering thought is the product of several days spent talking with bombardment men up and down the Atlantic coast. These men are the nucleus of America's hitting power, and they are eager to get at the enemy and smite him. But throughout these talks ran one theme—the urgency, the necessity of developing a combat team for every plane.

The kind of men who fight with airplanes do not talk easily about their intimate personal relationships. It was difficult to get at the simple details of what their teamwork implies, and the details they did point out were generally negative. As in marriage, the happy combination goes along smoothly and uneventfully; it is the unsuccessful relationship which causes talk.

"It's this way," said one Flying Fortress pilot. "If I don't like the color of my bombardier's eyes, or he doesn't like the cut of my jib, we just aren't going to get very good results, that's all."

And then, completely unaware, this pilot proceeded to give me a dramatic demonstration of the subject.

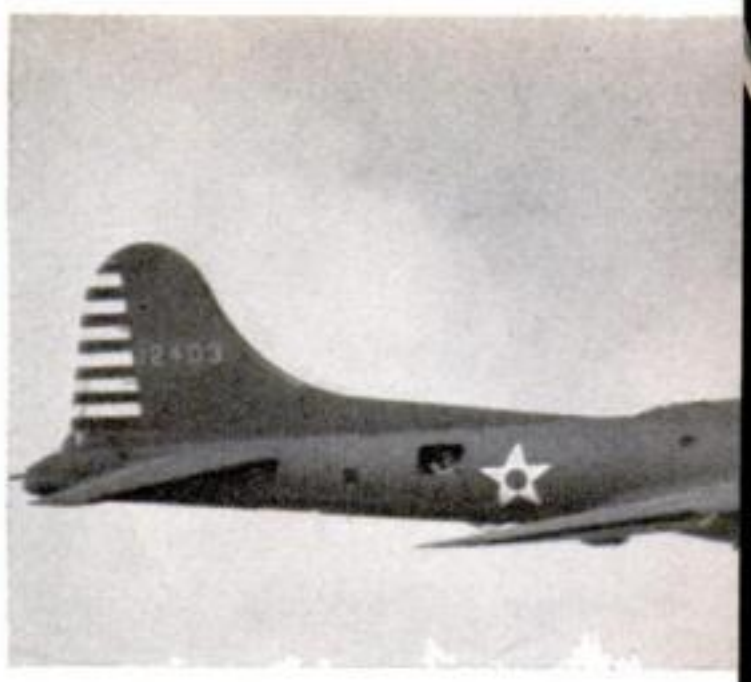
He had just brought his plane back from a patrol mission hundreds of miles over the Atlantic, hunting for submarines and sus-

Living and training together has unified the habits of these nine men; created a modern bomber crew. No one man could be quickly replaced, and without teamwork they would reach few objectives, hit few targets

2nd RADIOMAN AND GUNNER | 1st RADIOMAN AND GUNNER | BOMBARDIER | TAIL GUNNER | 2nd ENGINEER AND GUNNER | 1st ENGINEER AND GUNNER | NAVIGATOR | COPILOT | PILOT

*Bombardier.* Over a target, the bombardier at his station in the bomber's transparent nose is in virtual command as he sights and bombs. At that moment he is the center of the team, with the rest of the crew working to help him to hairbreadth accuracy. This photograph made by William Morris is reproduced on our front cover in full color

Operations officer (holding ruler) gives mission assignment to the pilots. Navigator and bombardier also will learn the flight plan



Each Flying Fortress requires nine

picious vessels. It was a six-hour mission and they had returned an hour and a half late. There was a pea-soup fog that morning, and it had been a tense and difficult day. The pilot had landed his four-engine ship, carrying full bomb load, and with a low ceiling.

I gathered that the difficulty had been with navigation. On the best day, navigation is difficult on this kind of mission, for you are frequently circling ships and otherwise changing course to complicate the calculations. It had been especially tough in this day's fog.

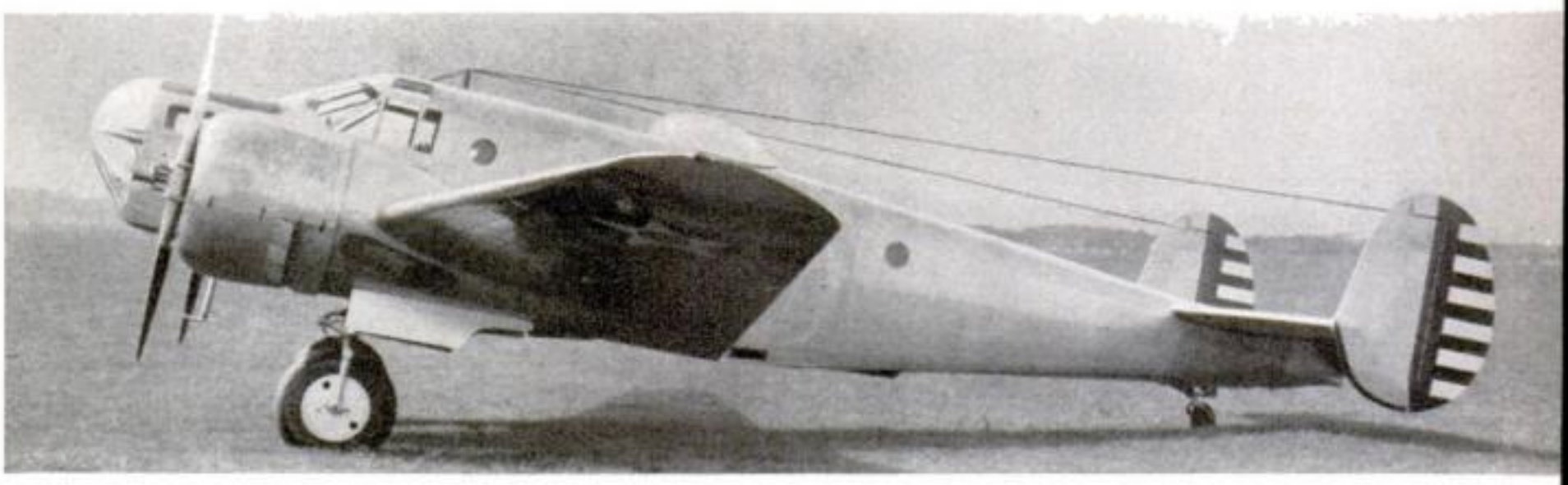
"We'll be all right," said the pilot, "when our navigator gets a bit more experience."

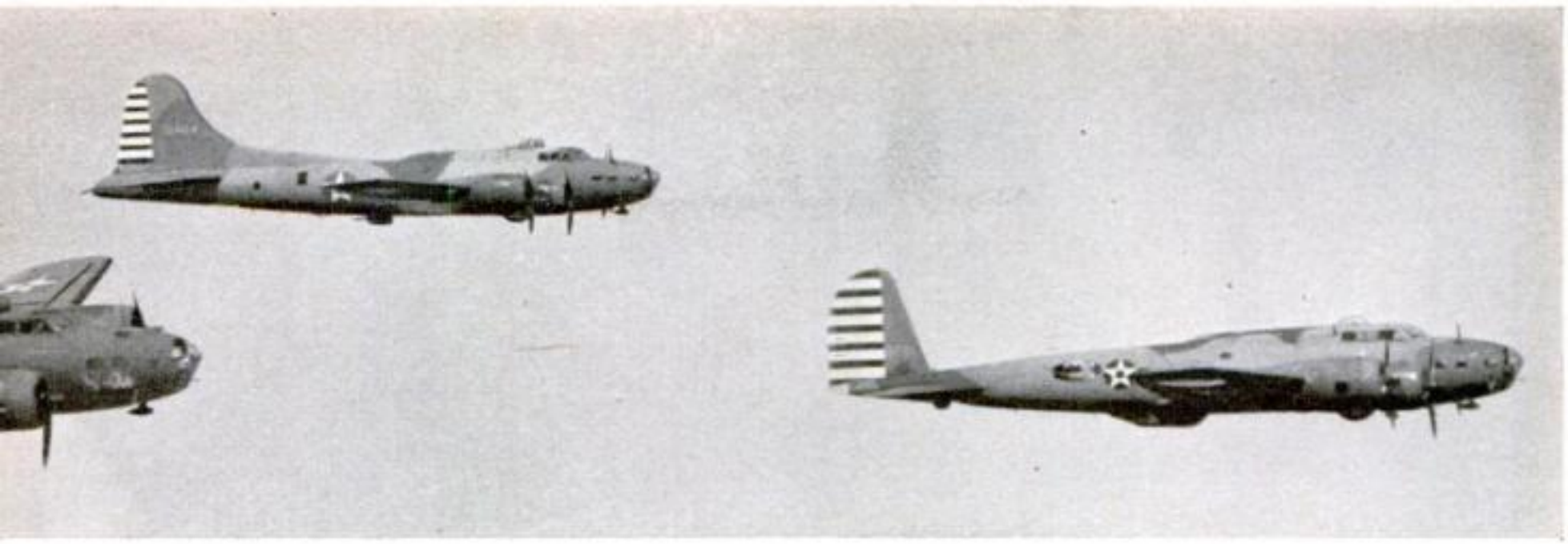
There it was. I knew, but the pilot did not yet know, that the navigator was quite as experienced as this pilot, if not more so. For six months he had been navigator for one of the best bombardment pilots in the American Army. He was accustomed, of course, to the ways of the pilot with whom he had been training.

Here were two good men who, in the process of expanding the Air Forces and reorganizing a squadron, had been put together for the first time. In a few days, or a few weeks, they would learn each other's peculiarities, learn to work together as a team. In the meantime, if you tried to send them out on a difficult bombing mission, it would be a fairly good bet that you would not hit the enemy effectively. On the other hand, you might very easily turn a fine ship and some splendid young fighting men into scrap metal and monkey meat.

America has staked her future on the striking power of the most complex weapons ever known to man, and of these the prime example is the heavy bombardment plane. Everything depends on our ability to hit the enemy where he lives. But as the great ships, the B-17's and the B-24's, come from the factories in increasing numbers, they are not yet ready for combat—not by a long shot. They will be ready after they have been manned by trained men who have been

For bombardier instruction of crews, this trainer has transparent nose, bomb racks, and gun turret





men aboard plus two maintenance men per engine aground. All such ships need complete relief crews

able to blend themselves into the intimacy of a family.

If you leave out the ground crew of two maintenance men for each engine, on whom all safety depends, the combat team for a four-engine bomber consists of nine men; pilot and copilot, navigator, bombardier, radioman with assistant, aerial engineer with assistant, and (in the newest planes) a rear gunner. All the last five must double as gunners, ready at any moment to step into the breach if another man is incapacitated.

Talk to the old-timers and they all tell you the same story of interdependence, almost as if they had learned it by rote:

The navigator gets you there. In some of this last year's bombing over Europe the bombs have landed as much as five miles away from the target. If anything like that happens, you might just as well never have started. The bombardier drops the bombs. While he aims he controls the ship. All of Captain Colin Kelly's courage and skill would have gone to waste, as he maneuvered at 23,000 feet over the Japanese battleship *Haruna,* if his bombardier had not been able to lay those three eggs where they could sink the ship.

The radioman must be on the alert. If he misses a weather message, the whole flight may fail. The engineer must know every rivet in the plane, and every circuit in its miles of electric wire. If something goes wrong, and he fails to tell the pilot, then everything may go wrong. And when the pursuit planes start swarming around, every one of these men in the rear of the plane must be able to handle a ma-

The ground-crew chief (coveralls) turns over to pilot a report on the plane's condition before a mission. His are heavy responsibilities: bomber, weapons, lives

**PILOT AND COPILOT** at the dual controls of a big bomber. Intensely trained, both are in constant contact with all other members of the crew via the interphone system. All their skill is useless unless the navigator guides them, radiomen keep them informed, gunners protect them, engineers keep them flying, and, finally, the bombardier blasts the target

**RADIOMEN.** Communication with headquarters and with accompanying ships is the job of a bomber's two radiomen. Ears of the ship as pilots are its eyes, they, like most of the crew, may take over manning of guns, or other tasks of injured mates

**NAVIGATOR.** He gets them there. The pilot will not find the objective, and the bombardier might as well be on the ground if the navigator muffs his job. He is shown above calculating the plane's drift

chine gun and shoot straight. Otherwise it would be just as well if they never had started. Or if the plane hadn't been built in the first place.

Through teamwork, processes involving precise calculations are reduced to simple, well-understood routines. When the ship takes off, for instance, one of the first things the pilot wants is a double drift reading to determine his true ground speed. As the pilot runs a straight course, the navigator looks down through his gyroscopic drift indicator, an optical instrument with its field of vision crossed by straight parallel lines.

Picking a stationary object on the ground, the navigator turns his lens until the object seems to move straight along the parallel lines, then takes a reading on a circular scale. For the double drift, the pilot turns 45 degrees off the course for a minute, then turns at right angles for another minute, then another 45-degree turn back to the course. From observations on these courses, it is possible to determine the effects of wind and ascertain the actual ground speed from the indicated air speed. But how does the

**GUNNERS.** Four of crew man .50 caliber machine guns in addition to their regular duties as radioman and assistant, and aerial engineer and assistant, occupying the gun blisters when attacked. A fifth gunner, selected partly for an impressive stomach stability, has a full-time job manning the bomber tail gun

pilot fly his ship? How sharply does he bank? Does he take his double drift to the left or right? Does he want to do it en route, or make the reading first and then start out from a given point? For accuracy and smoothness of operation these two men have to understand each other very well.

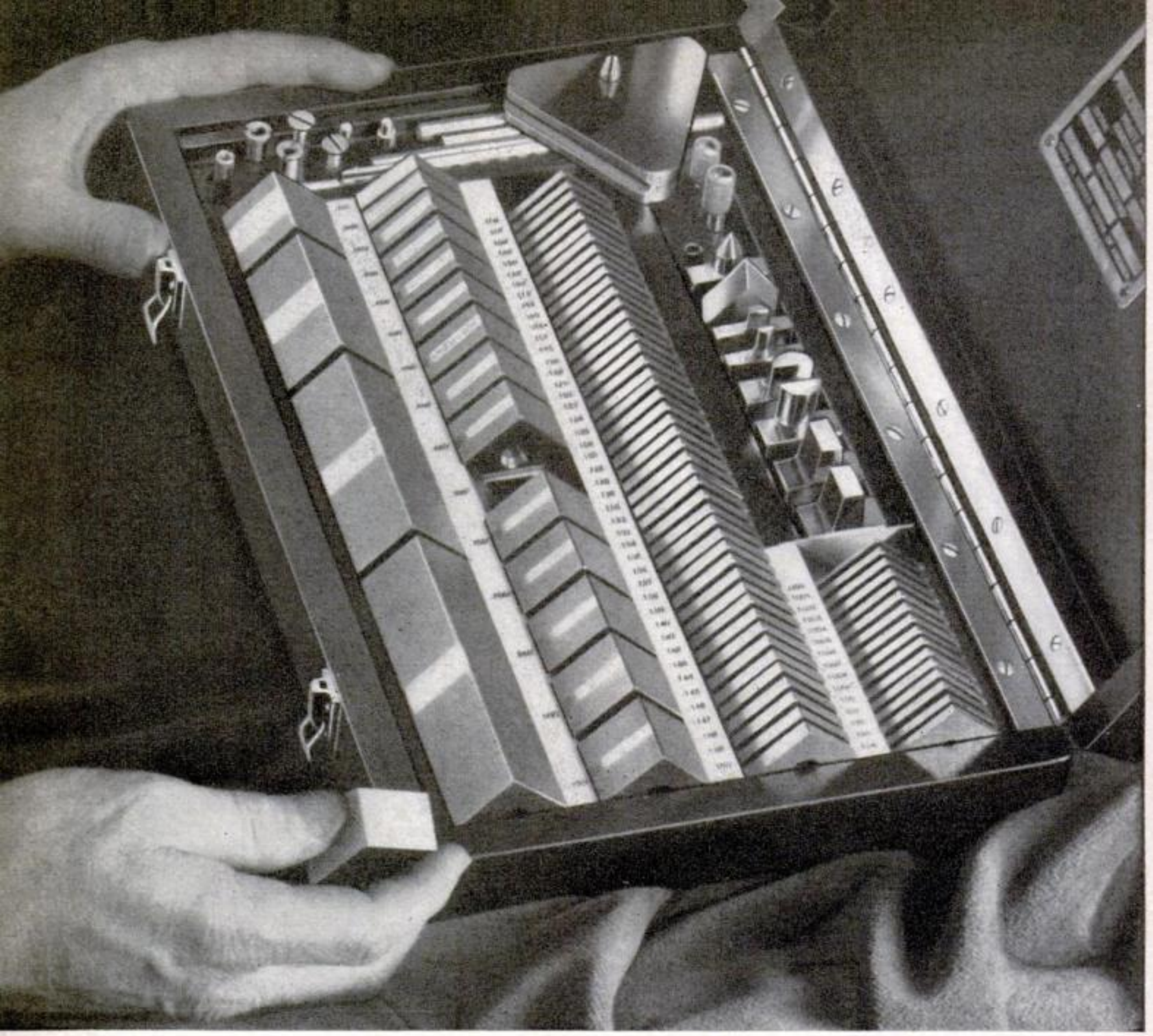
All executives are dependent on subordinates, but especially so is the pilot, who must guide his motored projectile for hundreds of miles and strike within a few yards of a specific point. The captain of a battleship has time to check over his navigator's work, if necessary; not so the pilot. He has to take the navigator's word.

Down in their cubbyhole below the pilots, the navigator and bombardier have their own teamwork. On the long voyage over, the bombardier has little to do, but he must be fit for his crucial moment. All at once he may be terrifically busy, making observations and all the corrections he has to make on his instrument. It's a help if he can take a drift reading from the navigator, instead of making it himself.

The pilot's dependence reaches its utmost at the supreme moment. At last the objective comes near.

And here is where the coördination of the team finds its best expression. No more than five words are spoken, perhaps not that many. Conversation under stress, especially at high altitudes, is too wearing and often unintelligible. Instead, the men communicate over the interphone system in a series of well-practiced, prearranged clicks —standardized and memorized at a bombardier school. Each man knows what he has to do, and trusts the other to do his share. The pilot, except in extraordinary circumstances, *(Continued on page 202)*

Broad visibility is afforded to the pilot by this high cockpit. Note the top gun blister above and behind him



A working set of Hoke gauge blocks. Its 81 blocks can be combined to give 120,000 different measurements

# INDUSTRY'S BUILDING BLOCKS

## These Magic Pieces of Steel Measure Millionths of an Inch for Precision in Manufacture

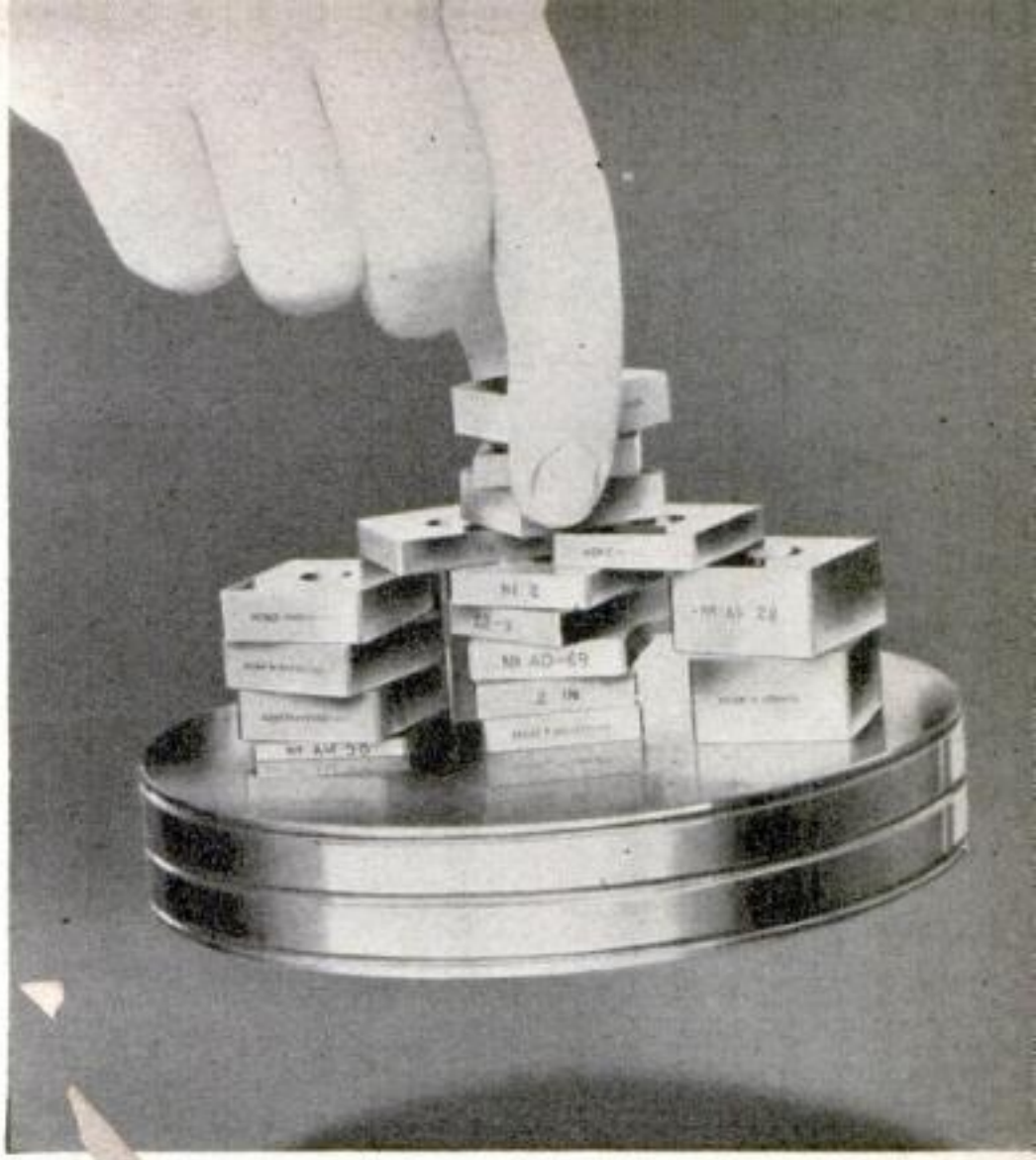
ALL over the United States, factories are making parts for guns, tanks, airplanes, and other machines for both war and peace. And when these parts are brought together for assembly, they fit precisely, without further machining or preparation. Such exactitude is the result of that major accomplishment of industry—interchangeable manufacturing; and interchangeable manufacturing in turn was made possible by the development of the precision gauge block, which is simply a piece of tool steel, hardened, ground, stabilized, and finished to an almost unbelievable flatness and accuracy.

These blocks, which have established the inch as a definite and identical value, form one of the basic factors of refined mass production. Sometimes they are applied directly to the work at hand or form part of a set-up for an accurate machining job. But more often they are used to check produc-

tion and inspection gauges which must be kept within prescribed limits. With them, measurements within one millionth of an inch are possible; any good mechanic can measure accurately within two millionths, 1,500 times as fine as a human hair.

Without precision blocks, the mechanical civilization of today could not exist, and methods of manufacture and assembly now accepted as commonplace would be impossible. The modern airplane and many other essential machines could not be made at all, and there would be only thousands of fine watches, automobiles, and instruments in the world instead of millions.

The first precision gauge blocks, made in 1897 by C. E. Johansson, a Swedish toolmaker, were accurate within one ten-thousandth of an inch. Ten years later Johansson had increased this accuracy to one hundred-thousandth, and in 1911, when the manufacture of the blocks was put on a commercial basis, he guaranteed them to be accurate within fifty millionths of an inch. Today special sets, for use in laboratories and in the manufacture of a few optical instruments in which only minute tolerances are permitted, are made with a guaranteed accuracy within two millionths of an inch. The ordinary working sets of all makers are guaranteed flat and parallel within five millionths of an inch, and to measure accurately within four or five millionths if used at 68 degrees Fahrenheit, the temperature at which the blocks approach absolute stability. A set of early Johansson

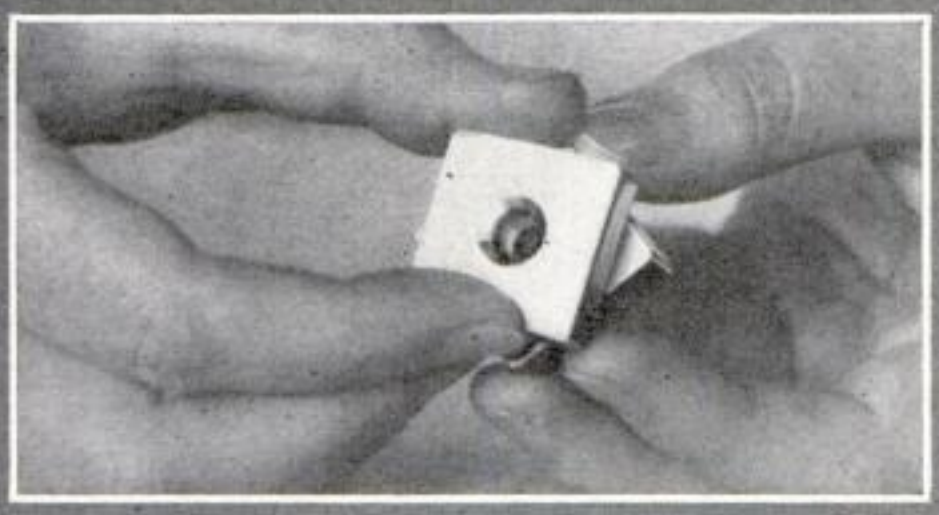


Gauge blocks wrung together in three stacks of the same overall height, and in turn wrung to a single block, stick together so tightly that the combination will support the weight of a toolmaker's flat

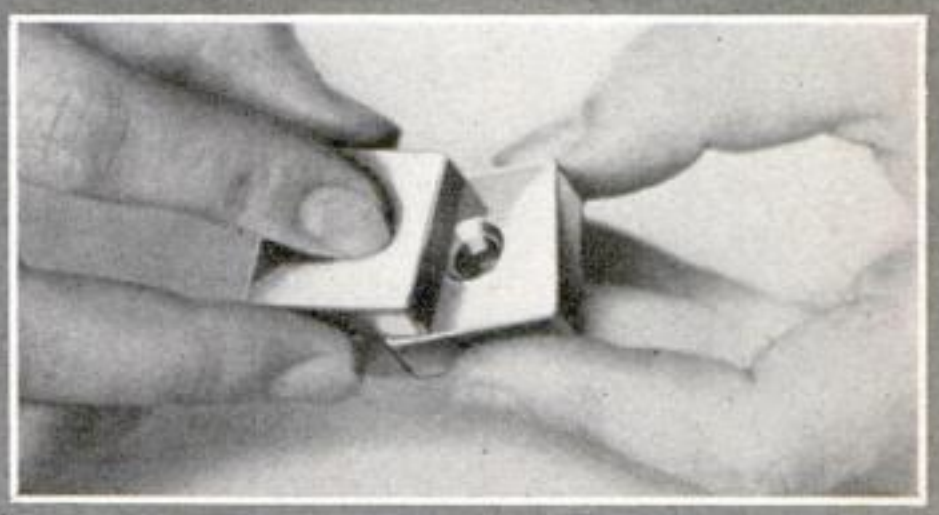
blocks, manufactured almost entirely by hand, is said to have cost between $2,000 and $3,000. Today a working set of 81 blocks, which can be combined to make more than 120,000 different-size gauges, may be bought for about $300.

The value of the blocks was recognized

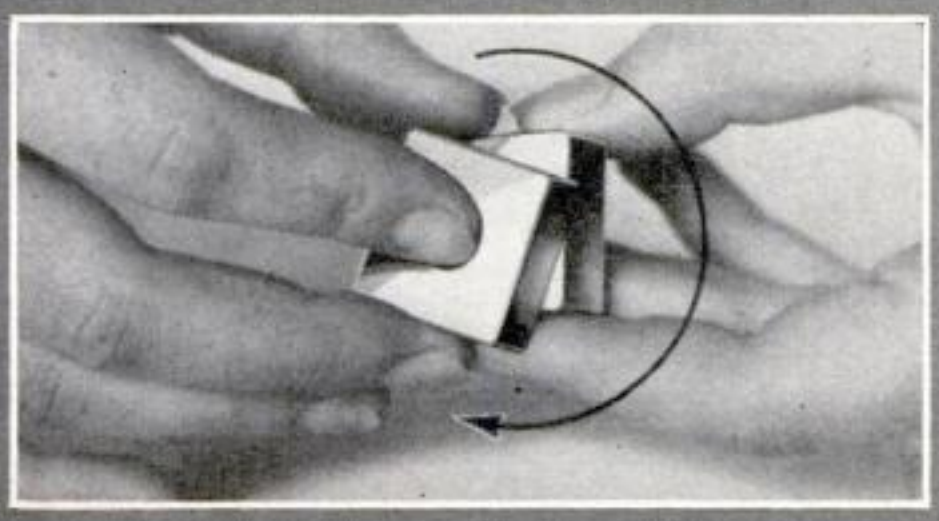
## How Two Hoke Precision Gauge Blocks Are "Wrung" Together



Blocks are first placed together as shown above, to reduce the danger of scratching one with the corners of the other. Then the upper block is slid over the other with a circular motion (see photograph below)



Light pressure now slides the upper block half out of engagement, then back into full engagement (below). These blocks are wrung, ready for use. Worn or dirty blocks will refuse to wring

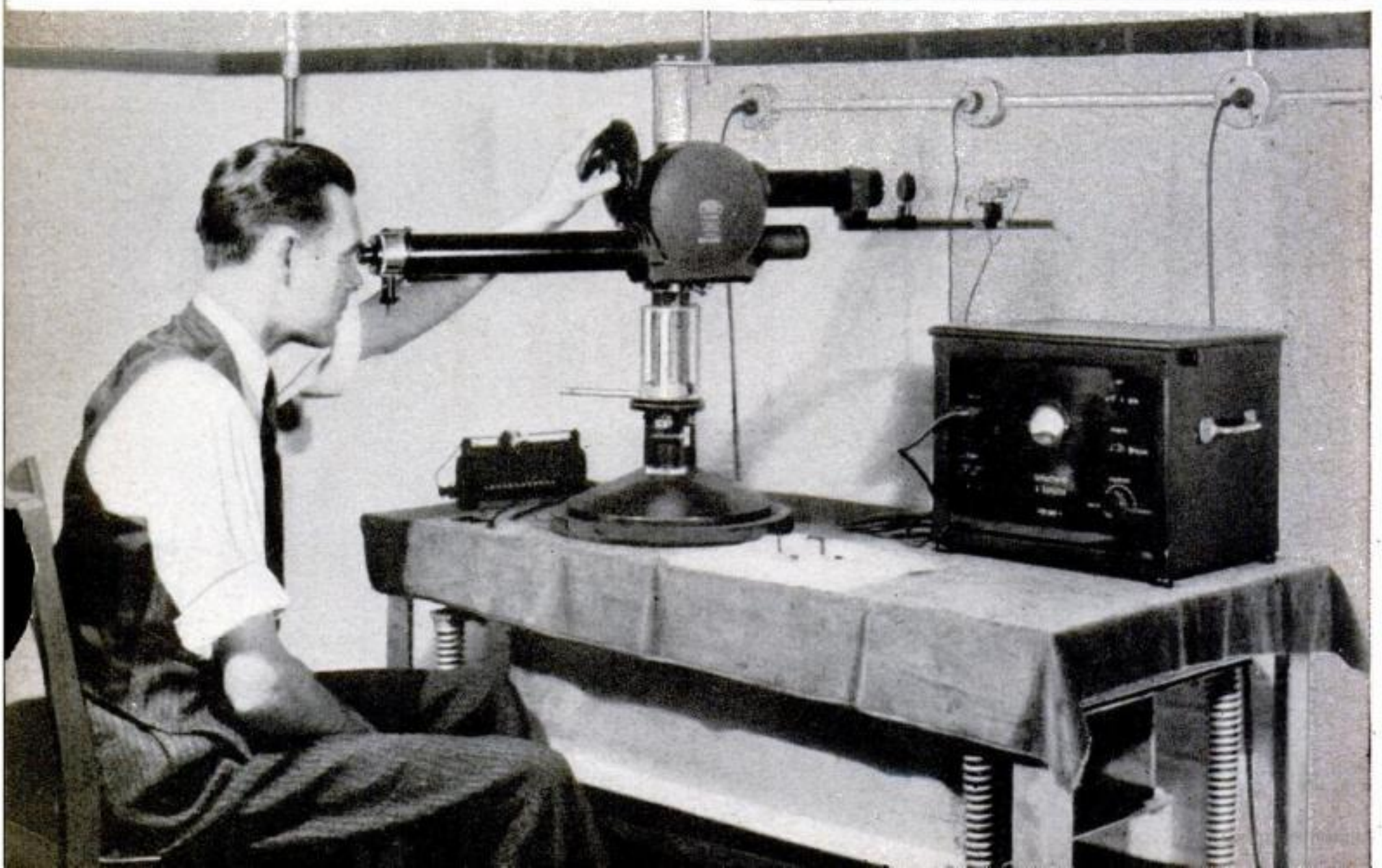


LAPPING MACHINES in which Hoke and USA gauge blocks are finished at a constant temperature in the Pratt & Whitney plant

A SPIDER (below) holds the blocks between the upper and lower laps. Here an operator is transposing blocks to distribute the wear

when the first World War showed the vital necessity of a dependable standard of measurement. All precision blocks in the country were requisitioned and apportioned by the Government, and for the first time in American industrial history it became possible to manufacture close-fitting parts in different localities and ship them to a central point for assembly. Interchangeable manufacturing had been transformed from a dream into a reality.

MASTER BLOCKS used in checking are calibrated, below, with an interferometer. They also go to the National Bureau of Standards for periodic testing



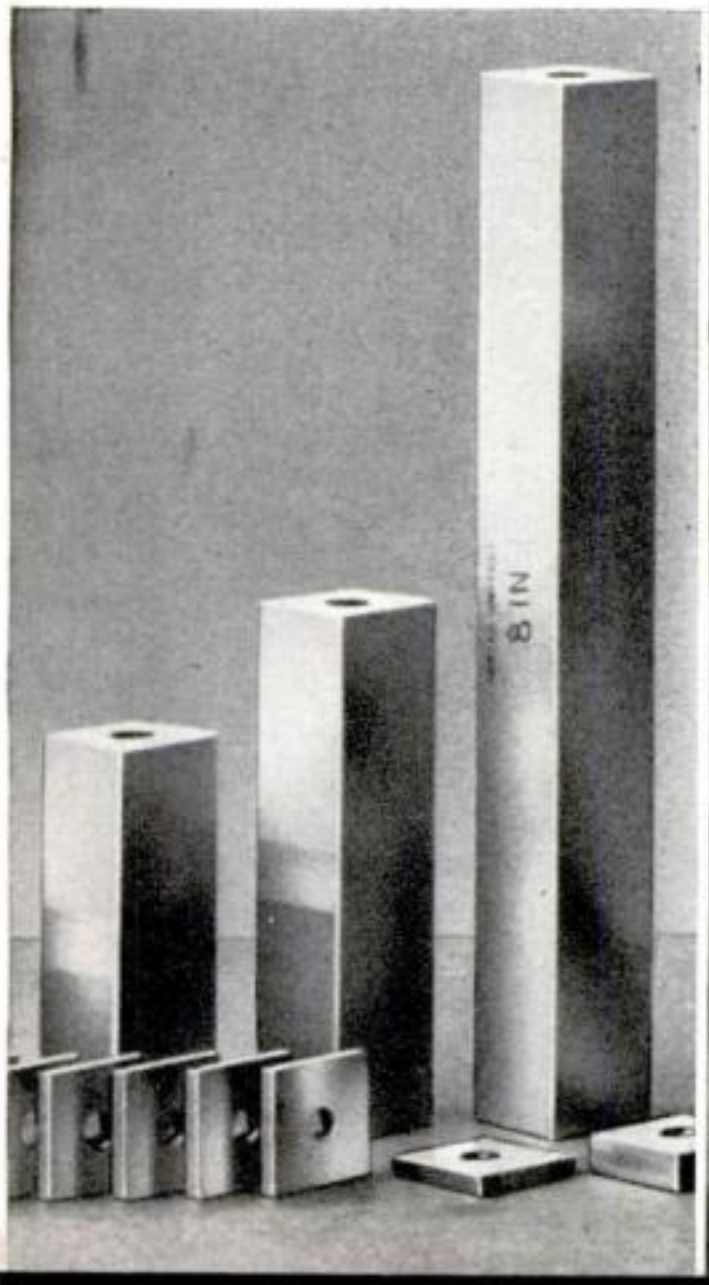
Precision gauge blocks are now produced in quantity by several American manufacturers, but the Johansson, made by Ford at Dearborn, Mich., are still the most widely used. Next are the Hoke and the USA, made by Pratt & Whitney at Hartford, Conn. Both the Johansson and the USA blocks are rectangular in shape, and when used in combination are held by outside clamps. The Hoke block is square, with a hole through the center. The square design makes for easier handling and greater safety when the blocks are stacked, and provides large symmetrical working surfaces; while the center hole permits the use of internal tie rods and other accessories for various purposes.

These rods, and the clamps used on the rectangular blocks, supplement a mysterious natural adhesion obtained by a process called "wringing," in which two perfectly clean blocks are slid one upon the other. As soon as the flat surfaces are engaged, they take hold as if magnetized, and cling together with remarkable tenacity. They can be disengaged only by sliding. Two blocks wrung together, with a suface contact of only 0.49 square inches, will sustain a weight of 200 pounds.

The exact nature of the force which holds the blocks is unknown. One theory is that the two surfaces come so closely together that the molecules in the one have the power to attract and influence those in the other. It has also been suggested that the capillary action of a minute film of oil on the surfaces is responsible for the adhesion. Whatever the force may be, its potentialities appear to be limitless. Perhaps in the distant future, if the precision of the blocks can be increased sufficiently to attain the absolute in flat surfaces, man may weld steel simply by bringing the pieces together at room temperature.

Precision gauge blocks are made of high-carbon alloy steel of the deep-hardening type, and possessing a very fine-grained structure after proper treatment. The man-

At the right is the setup for lapping long Hoke blocks to millionth accuracy. Below are specimen blocks. They are made in standard sizes from .01 to 20 inches in length. Countersunk holes permit use of tie rods and other accessories. Side surfaces are sandblasted



Establishing the legal rod: left feet of 16 men

## How Long Is an Inch?

Cubit: the forearm

WHEN man first began measuring things, he naturally took most of his standards of length from the parts of his body, just as he usually took his number systems from his ten fingers. Egyptian engineers laid out the pyramids in cubits, a unit based on the length of the forearm from the elbow to the end of the middle finger. Under King Henry I of England (about 1100), the lawful yard was fixed as the distance from the monarch's nose to the end of his thumb. In 1324, Edward II decreed that an inch was the length of "three grains of barley dry and round." The lawful rod of the sixteenth century was determined by lining up 16 men and measuring the combined length of their left feet. From the Anglo-Saxons we get the fathom, originally the distance across which a man can extend his arms. With the progress of civilization, requiring more and more accurate measurement, these units were given exact values which are recorded on standards carefully preserved by such agencies as our own National Bureau of Standards at Washington. All measuring devices, from the hardware-store yardstick to the machinist's accurate gauge blocks, get their authority by reference to these official standards.

The royal yardstick

Fathom: man's reach

ufacture of the Hoke block begins with the delivery to the gauge division of Pratt & Whitney of the rough steel bars, each 1 1/16 inches square. All four sides are ground to remove surface defects, and they are then held in stock for six months, when the oldest bars are withdrawn as required and cut to proper lengths. The faces of the blocks are ground, the corners chamfered and the center hole drilled, reamed and countersunk, and they are then hardened and tempered in electric furnaces, with automatic temperature control and special electric oil-tempering baths. After this process they are ground once more to remove any hardening scale.

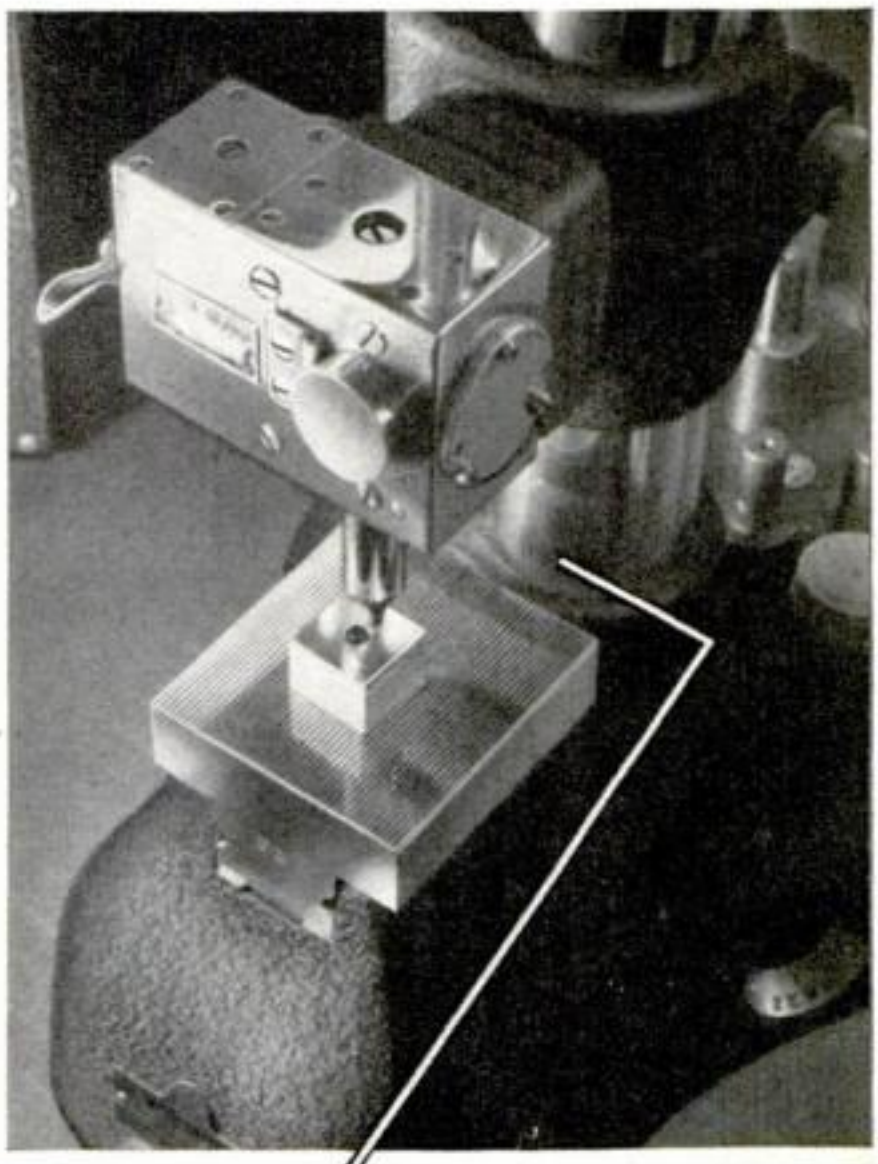
Various methods of artificially aging and stabilizing tool steel, consisting principally of alternate immersions in lukewarm and refrigerated solutions, have been used for many years with considerable success. Pratt & Whitney, however, after much experimenting and at a cost of more than $50,000, have perfected a method which permits higher hardening temperatures and lower draws, and gives the steel a higher hardening, in addition to virtually eliminating growth or shrinkage. This operation is supplemented by two six-month periods of natural seasoning, and as a result the atomic forces inside a Hoke block are so balanced that there is little or no tendency to change.

After artificial seasoning has been completed, Hoke blocks are finish-ground on an ordinary surface grinder. Since stamping would introduce permanent strains and destroy stability, each block is etched with the size and an identifying serial number. The blocks are now placed in storage for six months, after which they are put through the lapping or polishing process which reduces them to millionth accuracy. These operations, as well as checking and inspection, are carried on in a special room which is free from vibration, and in which a constant temperature of 68 degrees Fahrenheit is maintained. No smoking is permitted in this room, and visitors are excluded, as the blocks may be affected even by the heat thrown off by the human body.

Before the first World War the comparatively few precision gauge blocks manufactured were lapped

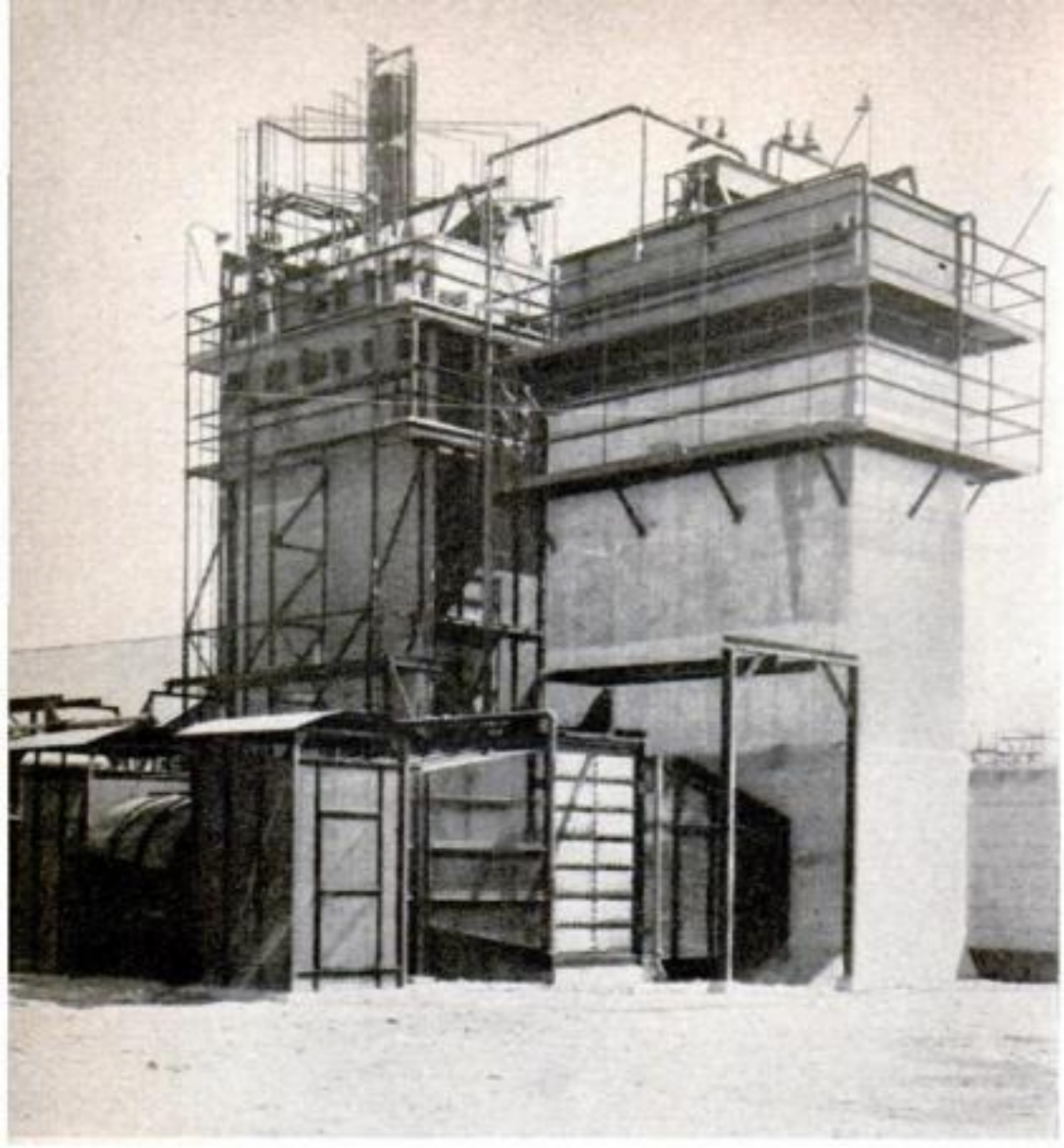
by hand, a long and tedious process, and never entirely satisfactory. Soon after the United States entered the conflict Major William E. Hoke, an Army engineer assigned to the Bureau of Standards in Washington, conceived the idea of mechanically lapping a number of blocks at one time to identical size within one millionth of an inch. On the machines now in use by Pratt & Whitney 24 blocks, held in a moving spider between two flat and highly polished laps made of heavy cast iron, can be lapped simultaneously. The laps, unlike those used to cut glass and gems and to polish cutlery, are immovable, but the spider has rotating and oscillating motions which produce such a complicated path of travel that approximately 300,000 revolutions are required before it is retraced. This tortuous course distributes wear evenly on the laps, aided by frequent transposition of the blocks. Only the weight of the laps rests upon the blocks, and the only abrasive used is "flour of emery," a liquid in which a small quantity of very fine abrasive is held in suspension.

Between runs on the lapping machines the blocks are tested for flatness and parallelism with a mercury vapor lamp and an optical flat, which is a round piece of fine glass with flat surfaces ground on it. The flat is placed over the block, and the interference bands in the reflected light show the comparative flatness. If the bands are straight, the block is flat. Completed blocks must also pass this test, as well as tests for extreme hardness. Finally, the blocks are checked by means of a millionth comparator against a set of grand master blocks, which are themselves checked at intervals by both Pratt & Whitney and the Bureau of Standards at Washington.—HERBERT ASBURY.



CALIBRATING production and inspection gauges is an important use of gauge blocks. At right, a Pratt & Whitney Electrolimit external comparator is being calibrated with Hoke blocks. Below, it is seen beside an internal comparator used to check wrist-pin holes in the pistons for outboard motors

# DIGGING DEEPER FOR COPPER

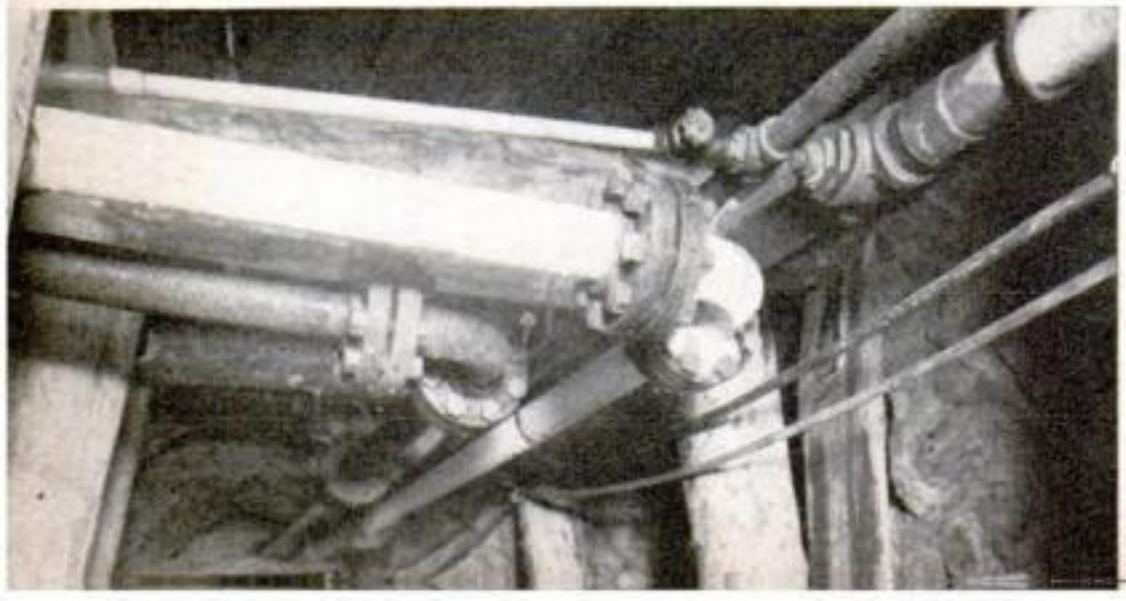


Cooling towers of air-conditioning plant for the "richest hill on earth" at Butte, Mont. A 47-degree drop in temperature can be obtained by using two water circuits

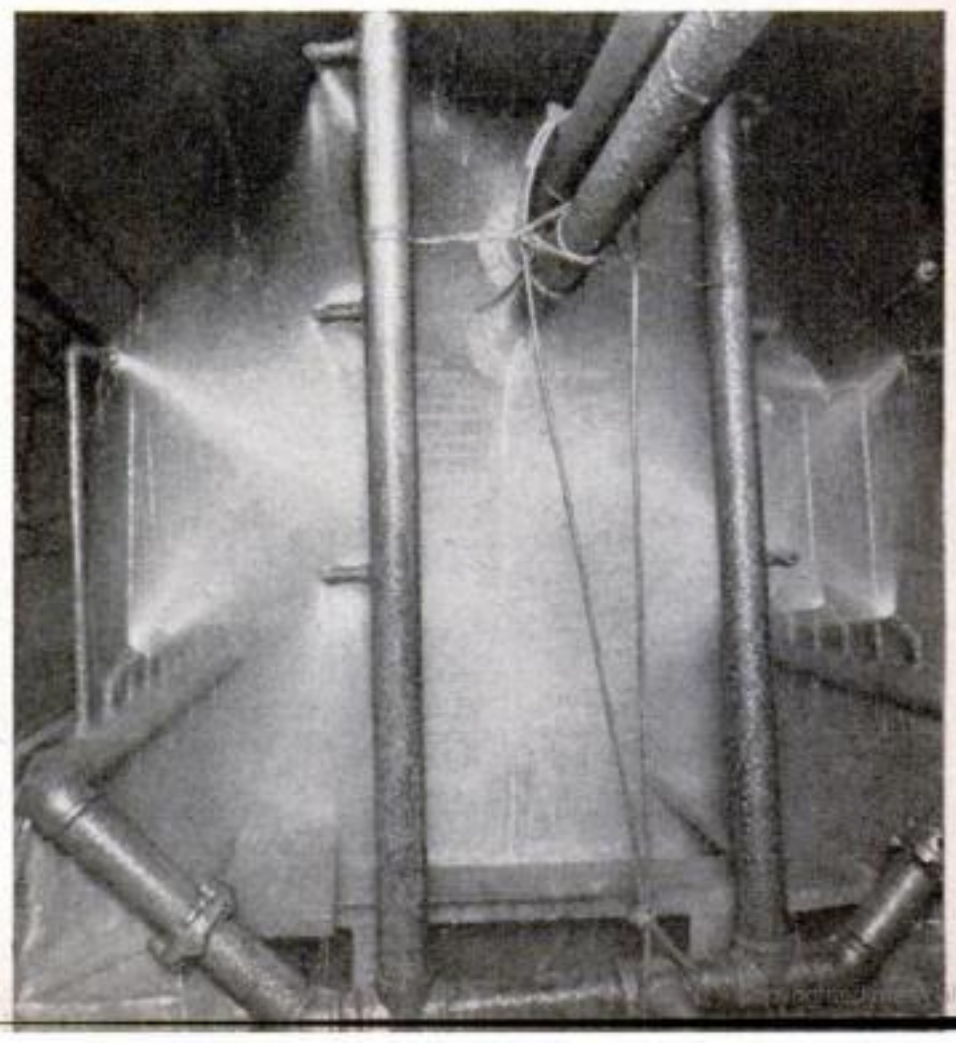
## Air-Cooling for Giant Mine Kills Heat that Once Made Lower Levels Hard to Work

A GIANT air-cooling system, as effective as the melting of 1,550 tons of ice daily, boosts war production of copper from the Anaconda mine in the "richest hill on earth" at Butte, Mont. Lower mine levels from 3,600 to 4,450 feet underground, with rock temperatures as high as 120 degrees F., could previously be occupied only in short shifts. Full-length shifts now work them in comfort. Cooled water from surface towers travels through heat absorbers resembling a battery of auto radiators, and returns to its source in a closed circuit, so that pumps need only overcome friction in the pipes; the weight of water going down balances the weight of water coming up. Ventilating air, pre-cooled in summer and sprayed to lay dust, circulates through about 35 miles of rubberized canvas tubing.

Sprays of water from atomizers are used for dust control in mine workings. All air goes through a spray shower before passing through underground ventilating system. Below, pipes in the lower levels are covered with frost as cool water from the surface towers is pumped through



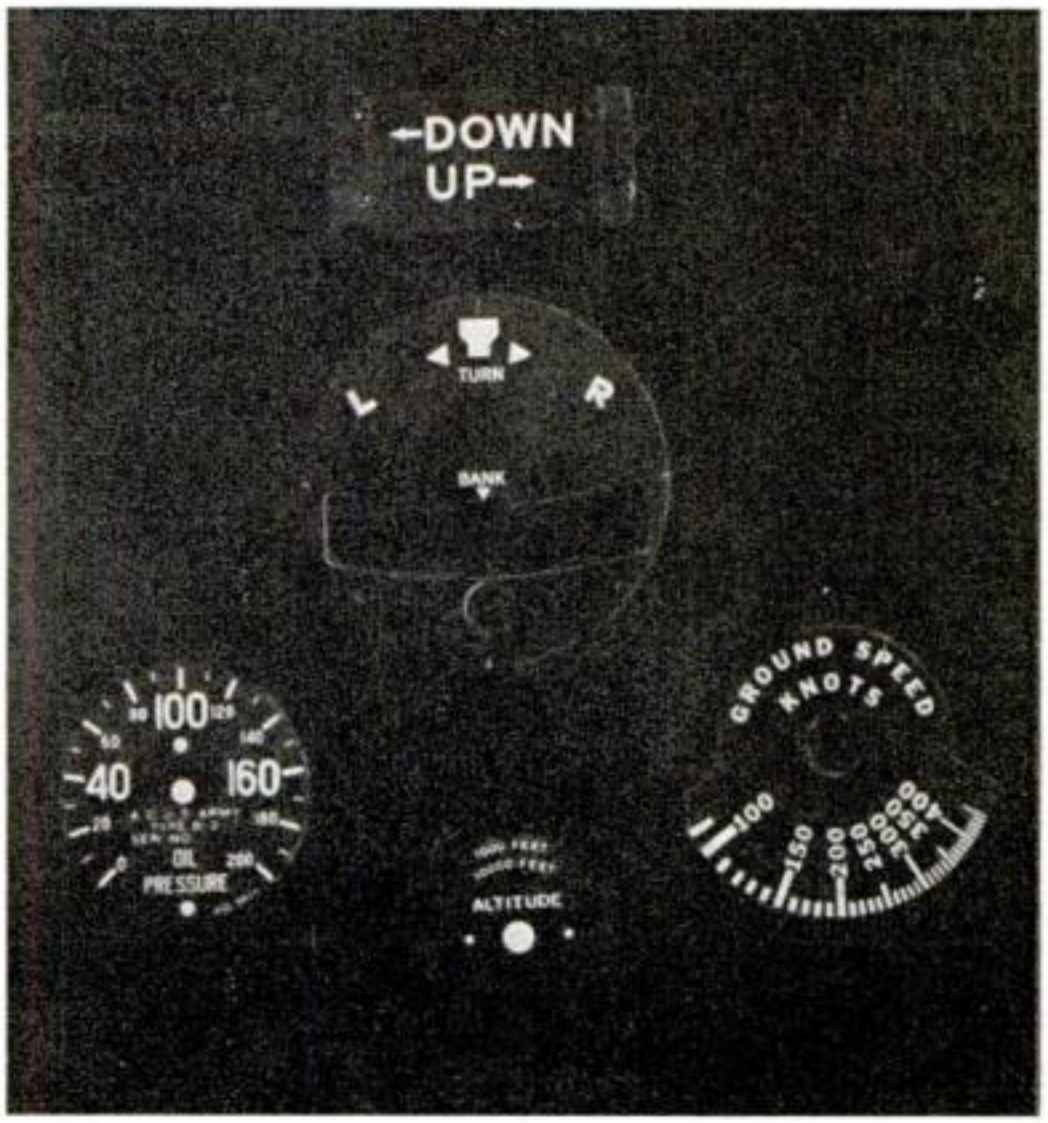
Below, air is washed clean of dust before passing through ventilating system, which cools it just as an auto's radiator would



# Black-Lighting Plane Cockpits

FLUORESCENT instrument dials, activated by small beams of "black light" which are not visible by themselves, are now being installed in the cockpits of fighter planes to replace the glaring dash lights. Standing out clearly against a black background, the necessary flight instruments are now easier for the pilot to read at a glance and require no adjustment of the eye from dark to light.

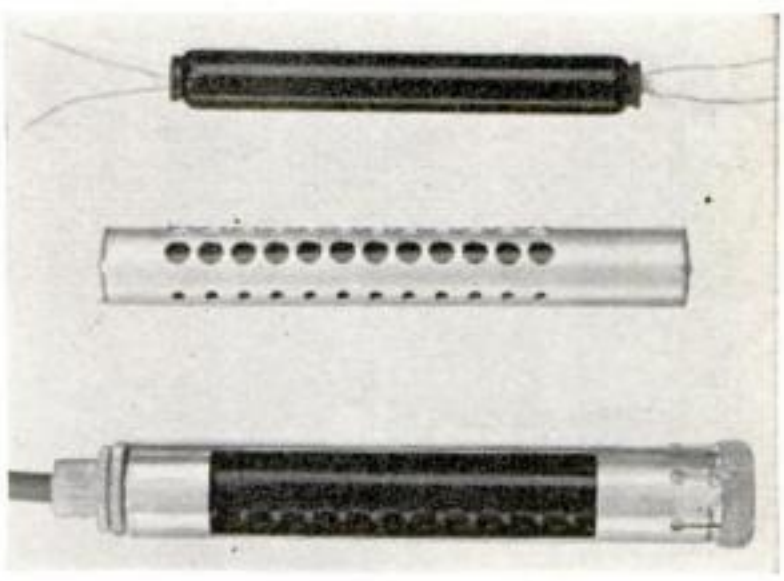
Unlike a motorist driving along an illuminated highway, pilots high above the earth have no source of artificial light from the outside. Thus even the smallest incandescent bulb glares in the cockpit. Considerable experimentation disclosed the fact that dials which glow within themselves cause less distraction than those illuminated from indirect light sources. The application of ultraviolet or "black light" to activate the dials and numerals painted with fluorescent materials was worked out to take advantage of this.




How the new fighter-plane instrument-panel lighting looks to a pilot. Fluorescent markings glow under ultraviolet-ray lamps

A small four-watt lamp, inserted in a cylindrical tube, furnishes the ultraviolet radiation. The tube, cut with rows of holes of varying sizes, can be rotated to furnish more or less light on the instrument panel depending upon the conditions within the cockpit. To insure adequate radiation over the whole panel, at least two light units are usually used. At the base of each unit is a small inverter which changes the D.C. supplied by the batteries to the correct power for operating the lamps. Starters are built into the tubular end of each of the special lamp units.

In the event that these ultraviolet units fail, a new phosphorescent paint has been developed that will make the instrument dials continue to glow for about two hours after the black light is extinguished.



Above, the top unit is the ultraviolet lamp; middle is perforated sleeve by which rays are focused. Bottom is a complete lamp unit

Left, engineers examine a four-watt lamp. Storage-battery current operates it through a small current inverter in each lamp base

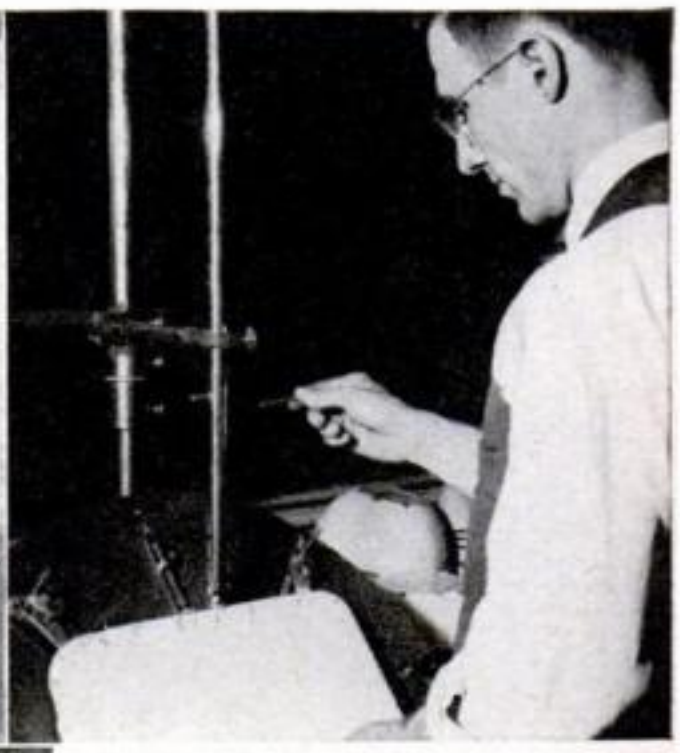
## Air in Bomb-Sight Plants Cleaned by Electricity

TO KEEP bomb sights and other delicate war equipment free from airborne dust, smoke, and noxious fumes while they are being manufactured or overhauled, the Army, the Navy, and civilian industry have enlisted a device that removes up to 95 percent of all dirt particles from the air. Known as the Precipitron, the machine is composed of boxlike cells about the size of up-ended suitcases. The dirt-laden air enters one end of the cell and passes over fine wires that hold a positive electrical charge of 12,000 volts. Behind the wires is a series of parallel plates, charged with negative electricity, which draw the positively charged dirt particles out of the air.

## Bouncing Ball and Boiling Water Used to Test Enamelware

TO DETERMINE the strength and resistance of different types of enamelware, scientists at the University of Illinois have subjected nearly 5,000 enameled items to abusive tests such as might be duplicated in the home. Resistance to bumps and bangs is tested by allowing a three-quarter-inch duralumin ball to drop on an enameled dish from a height of 11 inches. Thermal shock is tested by allowing water to boil from a dish and then filling the dish with cold water before it has a chance to cool. As a result, enamelware is being improved and new standards are being adopted.





The hot-and-cold test for enamelware (above, left), in which cold water pours into a pan which has just boiled dry. Above, a ball drops on the utensil until the enamel finish cracks

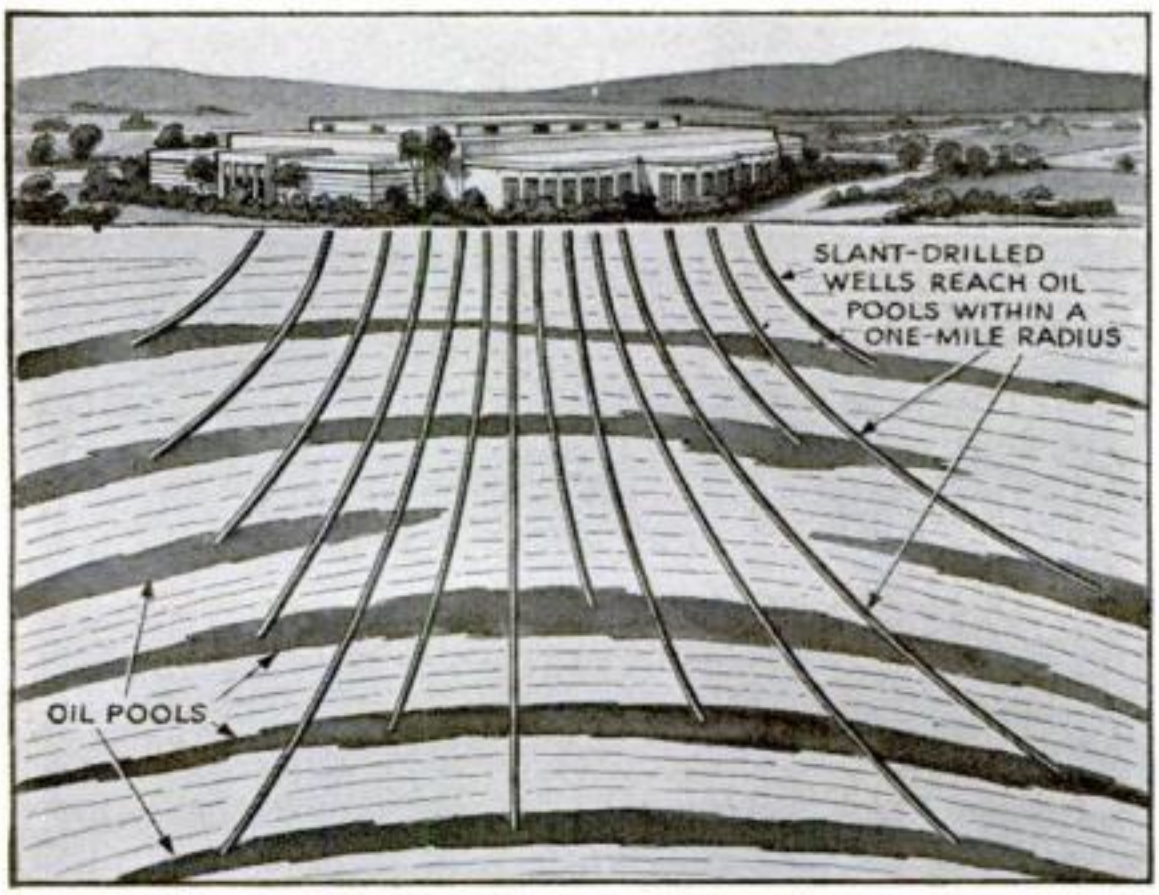
Left, research man shows the result of ball test on pans, which must resist a drop from 11-inch height


## Army's Crash-Boat Fleet Saves Flyers from Water

SPEEDY crash boats, manned by seagoing soldiers of the U. S. Army, are now being used to rescue aviators forced down in open water. Four men, specially trained in first aid and rescue work, are carried on board to render aid until the victims are safely brought to shore. Although the crash boats are designed for rescue work, they might be subjected to enemy fire while carrying out their mission and therefore are lightly armed.

Four men specially trained in first aid and rescue work are part of the crew of the fast Army crash boat pictured above

## Indoor Oil Field Would Protect Wells from Enemy Bombs




Proposed concrete building to shelter oil wells and refining works

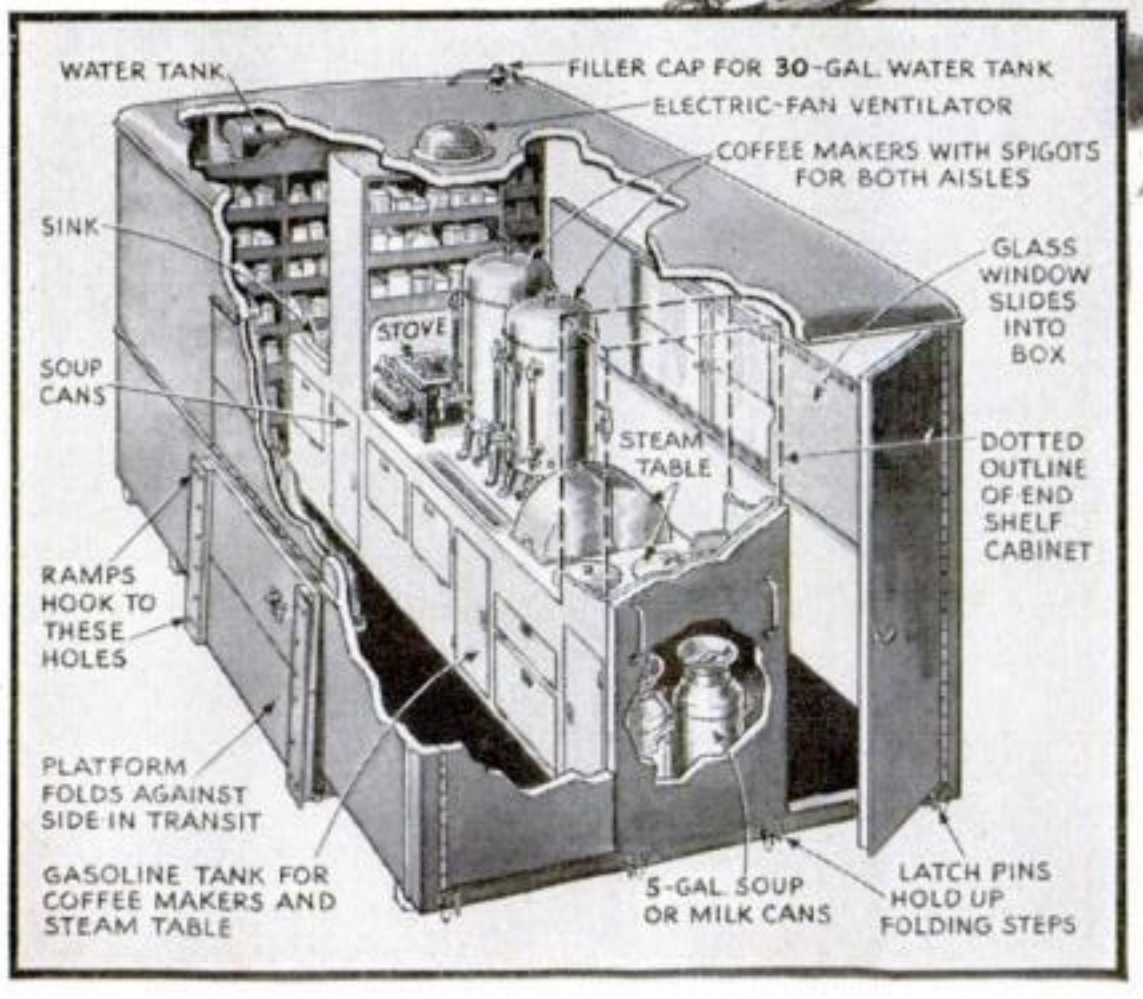
TO PROVIDE a source of high-octane aviation gasoline that would be inaccessible to enemy bombs, plans were recently submitted to the Los Angeles City Council for an indoor oil field under the city. The plan provides for a light-, sound-, and odorproof concrete building to cover slant-drilled taps to various oil pools under the surrounding area. As the oil pools are found at different levels, several taps would be drilled to various depths. Pumped into the building above, the oil could be stored and refined under protection. The estimated cost of the proposed building is $3,000,000.

# ARMY KITCHEN ON WHEELS

## *Stores, Cooks, and Serves Food*

The platforms fold up against the sides and ramps are placed inside the truck while in transit. Two cooks man the mobile unit

Below, the cut-away drawing of the truck-kitchen body shows how compactly the equipment is arranged




Drawings by
STEWART ROUSE

Soldiers file over ramps past windows on each side as cooks dispense food. The unit serves 200 at a time

FULLY equipped to feed hot rations to 200 hungry soldiers in the field, a mobile kitchen recently developed by the Army contains a large stock of food and unusual serving facilities. Running lengthwise in the middle of the kitchen is a bar supporting two coffee urns, a steam table, sink, and stove. Beneath the bar are lockers for storing utensils, provisions, five-gallon cans for soup or milk, and a gasoline tank for the cooking burners. Fenced-in shelves for small provisions cover the forward wall. On both sides of the steam table are aisles for the cooks. At mess, the soldiers file up to serving windows on either side of the unit by means of ramps, which are stored in the aisles when the kitchen is moving.

# War Goggles

## HAVE INTERCHANGEABLE PLASTIC LENSES

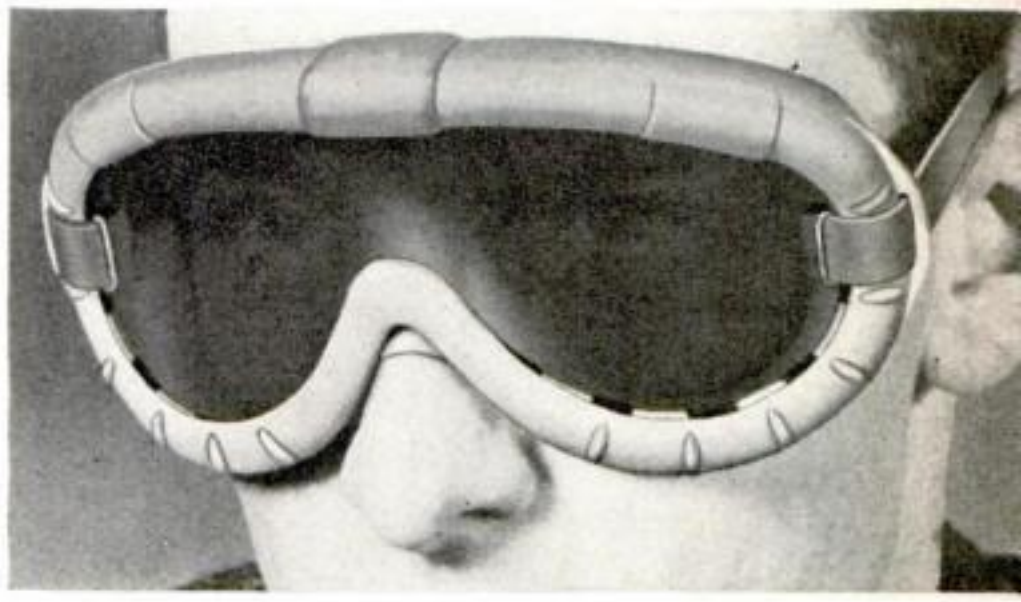
A REVOLUTIONARY war goggle with interchangeable lenses, designed to afford maximum protection against wind and glare and to adapt the eyes to night vision without the necessity of a "blind period," has been perfected after almost a year of joint research by scientists of the Polaroid Corporation of America and the Medical Research Section of the Navy's Bureau of Aeronautics.

Wearing the dark-adapter lens, a pilot can precondition his eyes while studying his air plot or working on his navigation chart, or a sentry while dressing or getting ready to go on duty. It is described by the Navy as "a thin, red color filter bonded between two layers of optical plastic, which allows practically no light to stimulate the portion of the retina used in night vision." A half hour of wearing it cuts to three minutes the time needed in full darkness to attain maximum night vision.

Three other types of interchangeable plastic lenses are made—a green-tinted lens, which is a polarizing, anti-glare filter, a clear lens for protection against wind, and a green non-polarizing lens. The green and clear lenses are packed in a kit for ground troops and tank crews. All lenses are precision surfaced by a secret process.

The frame, constructed of a single piece of molded sponge rubber, embodies a basic new design. It contains no leather or cloth, and no metal except a small one-piece buckle for adjusting the headband. It has a single aperture, thus eliminating the blind spot usually caused by a nosepiece or hinge. The lens when fitted into the frame is held by four snap fasteners and the pressure of the headband, but may be removed and a new one inserted in a few seconds. Indirect ventilation ducts encircle the top of the frame, and prevent fogging and sweating around the eyes.

Protection against wind and glare is provided by this new goggle, fitted with a plastic, polarized filter, shown above, or against long periods of night blindness with the dark-adapter lens below



Lenses are quickly changed. The ends of the strap fit in slots near the outside edges

Next, the strap is pulled down and the new lens brought against the specially designed frame of molded sponge rubber

Then four fasteners—three on the upper rim and one on the nosepiece—are snapped

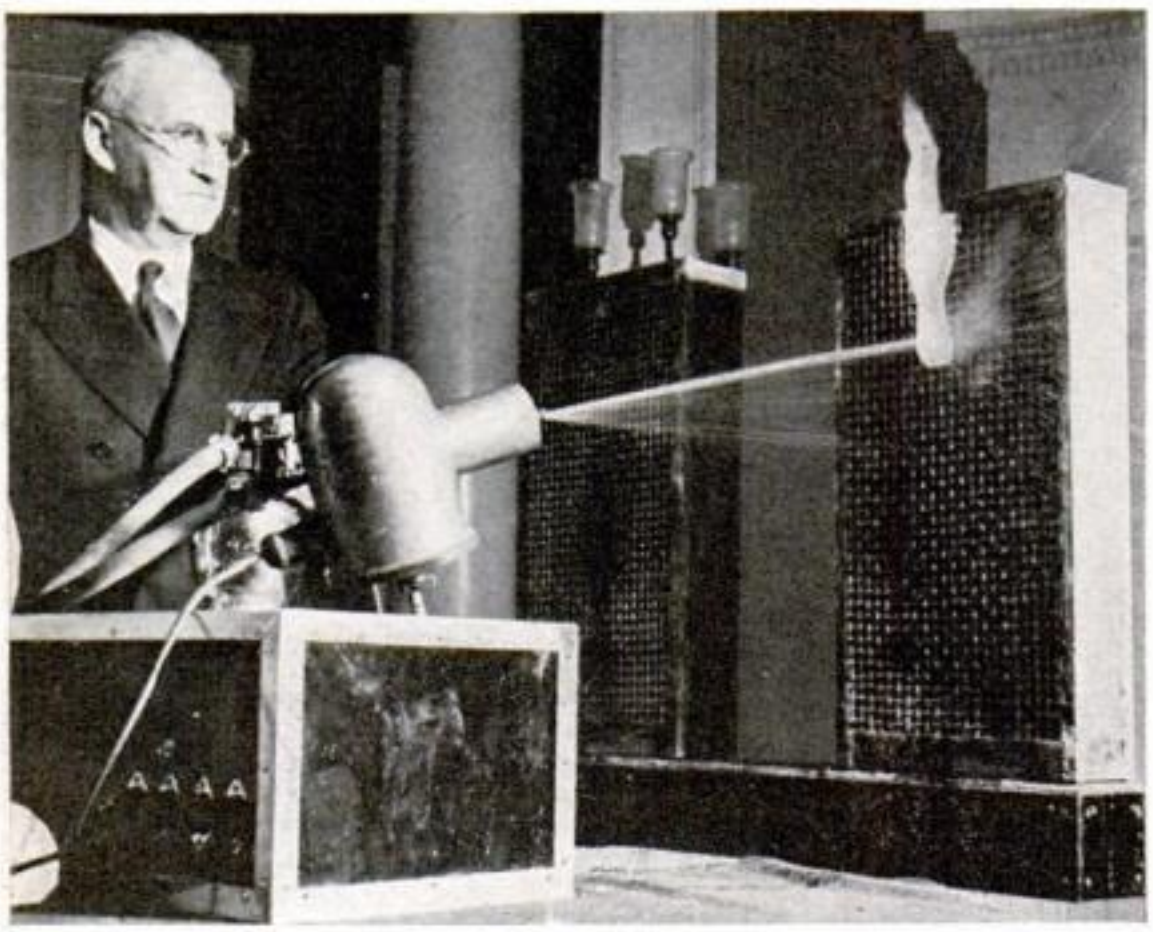
# Plastic Mats for Duplicating Machines Beat War Priorities

Difficult drawing at right was printed on a duplicating machine with the aid of one of the new plastic mats

Joseph E. Gilligan, below, inspects work done by one of the mats he developed

BECAUSE Joseph E. Gilligan spoiled a shirt operating a duplicating machine in 1926, the lithographic industry today has two new plastic mats, substitutes for war-requisitioned metals. The stain on his shirt led Gilligan into research work on synthetic resins in an effort to find something better than liquid stencil duplicating and resulted in the development of Lithomat and Photomat. The latter, for photo-offset work, can be sensitized to receive photographic images. The translucent Lithomat can be used for direct-image work, particularly for forms, facsimile reproductions, and line drawings which can be copied directly onto the mat.

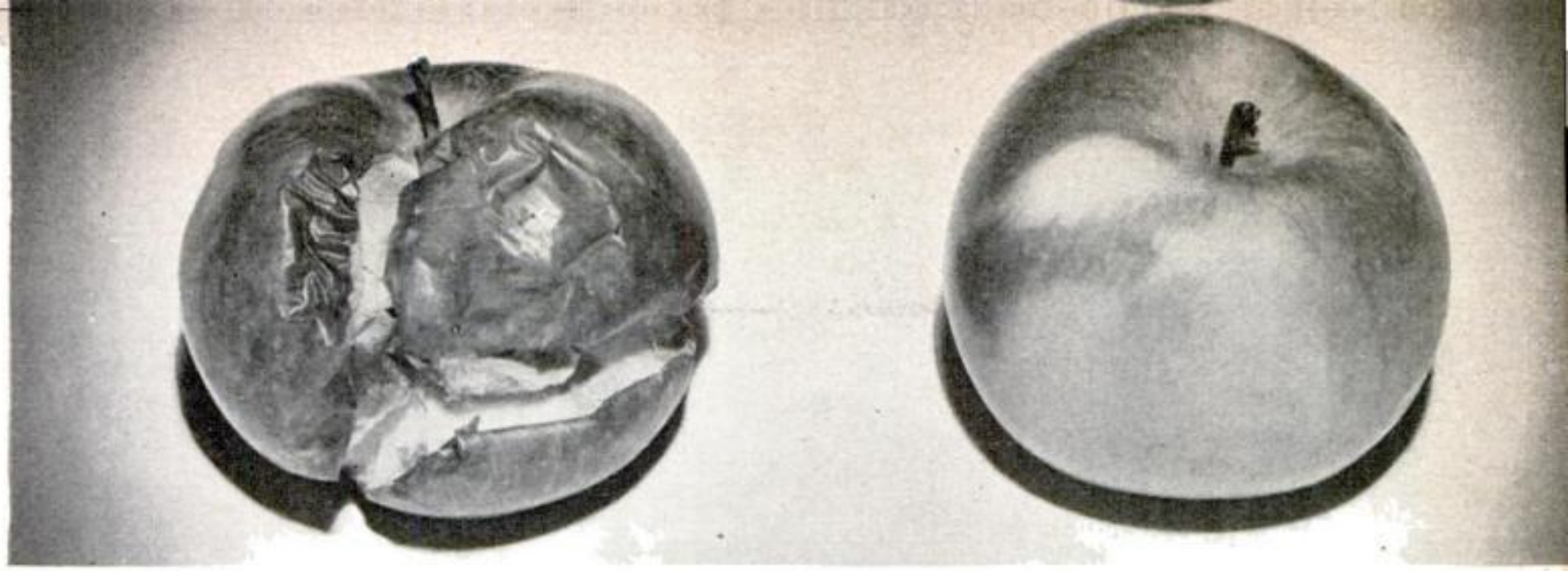
# Robot Fireman Automatically "Sees" and Puts Out Fires



Stream from the robot fireman plays on a blaze it found with its roving electric eye. "Sight" of flames started the extinguisher

A ROBOT fireman which searches for and automatically extinguishes fires has been developed by research engineers of the Westinghouse Electric and Manufacturing Company. A photo tube, or "electric eye," is installed in a brass dome with a snout through which passes a tube connected to a fire extinguisher. When a motor is started the dome travels up and down and back and forth in a scanning motion.

If the robot "sees" a fire, light from the blaze, flashing on the electric eye, throws a switch, stops the scanning motion with the snout pointed at the flame, and opens the valve of the fire extinguisher, which directly sprays the base of the flame.



The McIntosh apple at left was kept a year in cold storage; the other, in a controlled atmosphere

# Apples Put to Sleep in Thin Air Stay Fresh

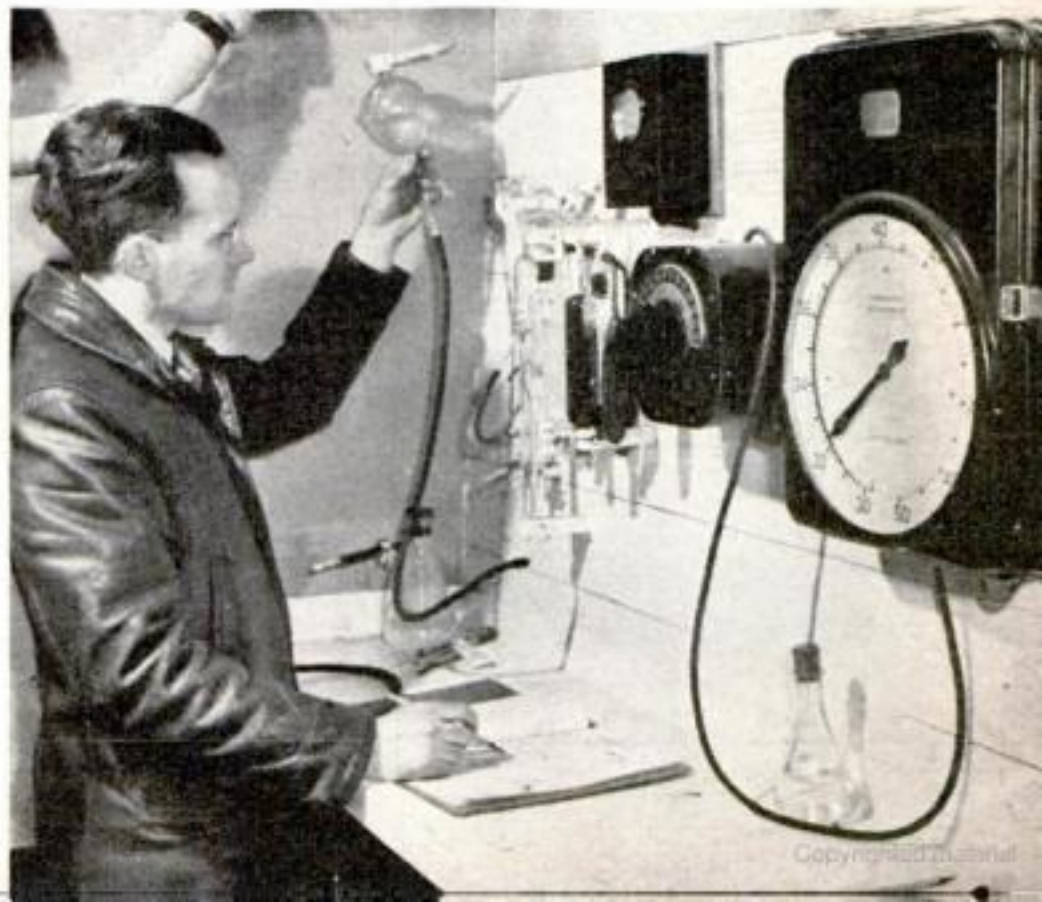
BY slowing down the "breathing" of apples in a controlled-atmosphere chamber, packers can now put year-old fruit on the market in almost the same condition as the day it was picked. This process, perfected by Drs. Robert Smock and A. Van Doren of Cornell University, literally puts the apples to sleep in a cool, modified atmosphere until they are ready to be used.

Because apples breathe oxygen and exhale carbon dioxide in much the same manner as human beings, their respiration eventually burns up the fruit's sugar content. Slowing up this respiratory process by the usual cold-storage methods preserves the apples, but not long enough to keep them marketable throughout the year from one picking to the next.

Through experimentation, English scientists found that when apples were kept in a sealed chamber in which the oxygen content was allowed to drop from the normal 21 percent to two percent and the carbon dioxide was allowed to build up to five percent, some types of fruit would last three times as long as under regular storage conditions.

To insure the correct combination of gases at all times, a technician takes samples of air from storage chambers at regular intervals. If the carbon dioxide content is too high, the atmosphere is washed to reduce it.

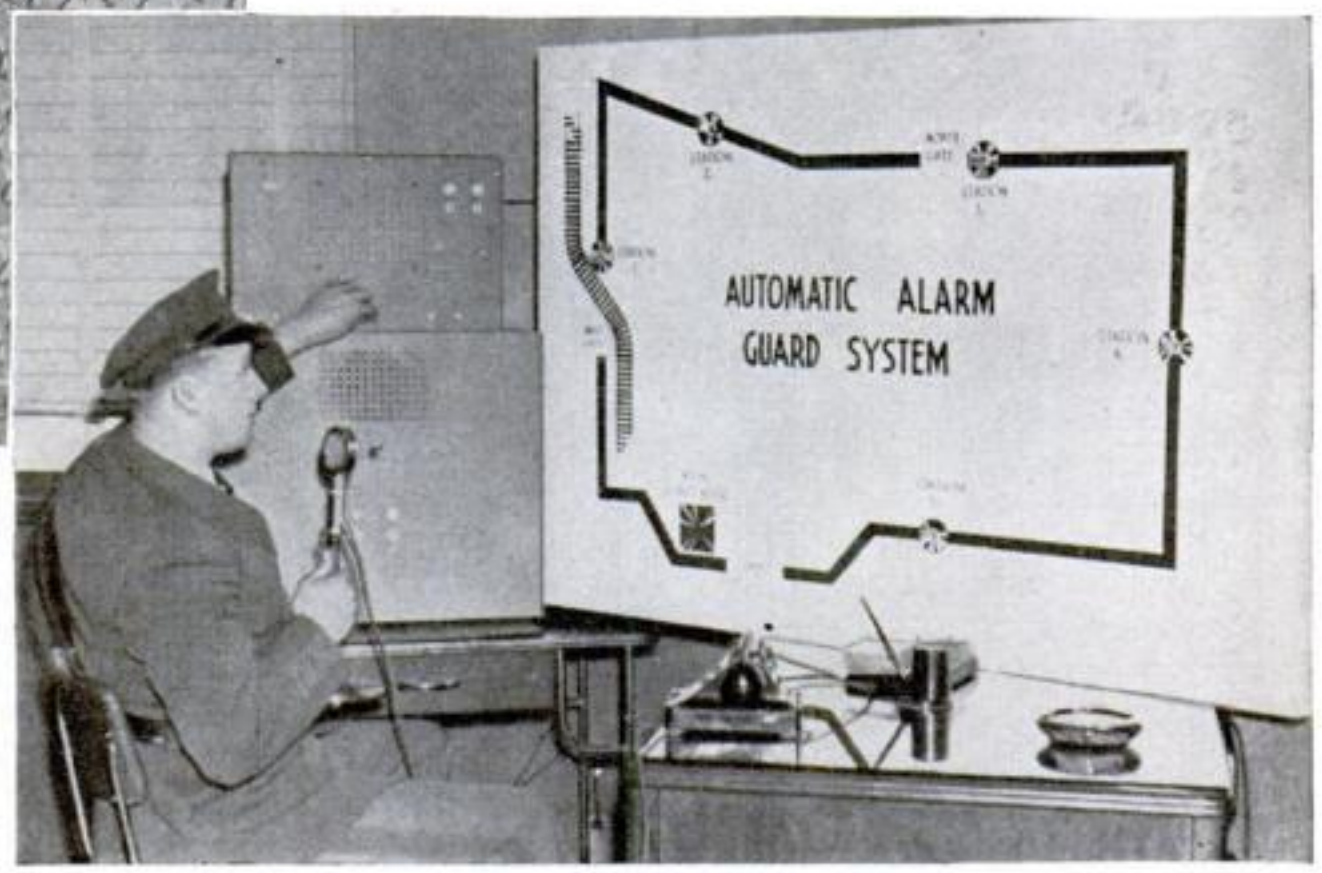
In the control room of Cornell University's apple-storage plant, below, pipes from the six storage rooms make it possible to check their gas content



How much does an apple breathe? Dr. Robert Smock determines the metabolic rate by measuring amount of carbon dioxide they exhale in a test

## Defense-Plant Fences Have Ears to Block Prowling Saboteurs

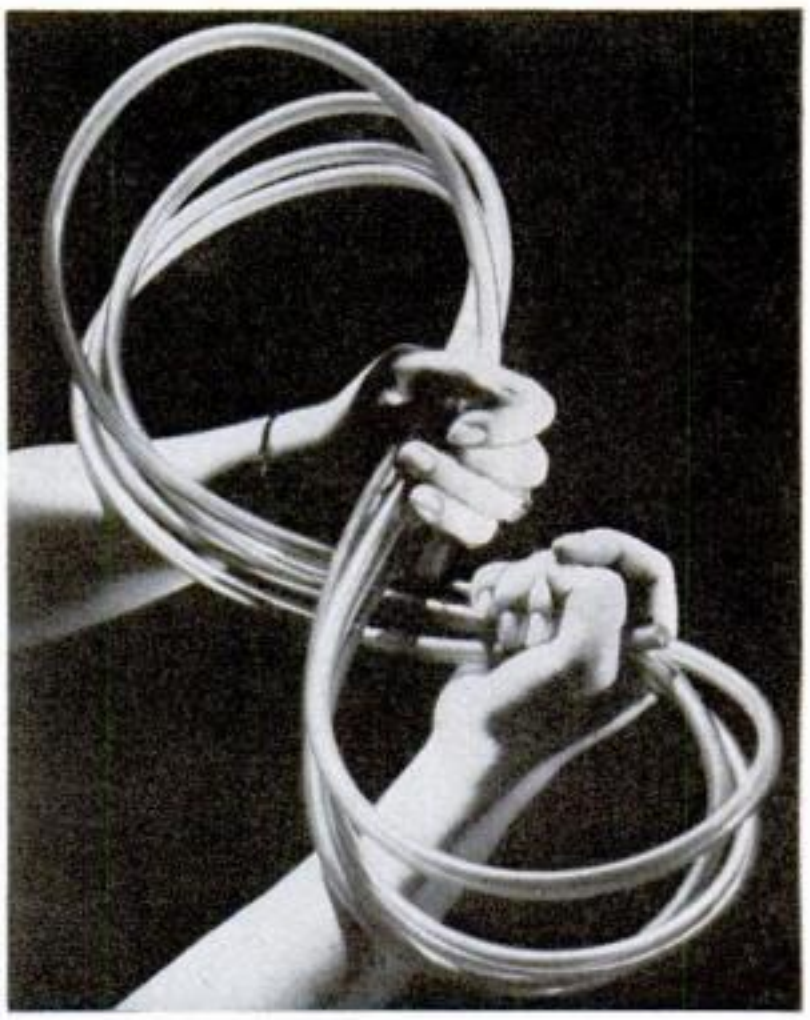
POSITIVE protection against prowlers in one defense plant is achieved by means of a special "acoustic fence." Sensitive magnetic pickups, located at intervals along the fence, react to the slightest vibration and cause an alarm to ring in the main guard room. If wires are cut, a general alarm rings until the break is repaired.




Magnetic pickups like this detect any tampering with fences around a war-production plant. The slightest vibration . . . is amplified in the main guard room, where a bell rings to call attention and a flashing light shows location

## Plastic Tubing to Replace Metal Is Flexible, Corrosionproof

TO REPLACE some types of metal tubing, a new thermoplastic substitute has recently been developed that is said to be strong, flexible, and highly resistant to chemicals. Known as Saran, it can be used for gasoline lines in automobiles, lead-in pipes for corrosive fluids, air and water lines, and many other purposes. This new plastic tubing is available in sizes ranging from ⅛ to ⅜ of an inch in outside diameter and with various wall thicknesses of from .030 to .062 inch. Joining the tube may be accomplished by means of standard flare-type fittings. At room temperature, flaring usually can be done with standard equipment, and necessary trimming is accomplished with a knife, scissors, or file. Because of its special qualities, Saran is a suitable replacement material for copper, nickel, stainless steel, and ceramics in several fields of use.



Tubes of Saran, the new thermoplastic that replaces metal piping for many uses, can be bent almost double without breaking

Joints can be made with flare-type fittings, several types of which are shown at the left

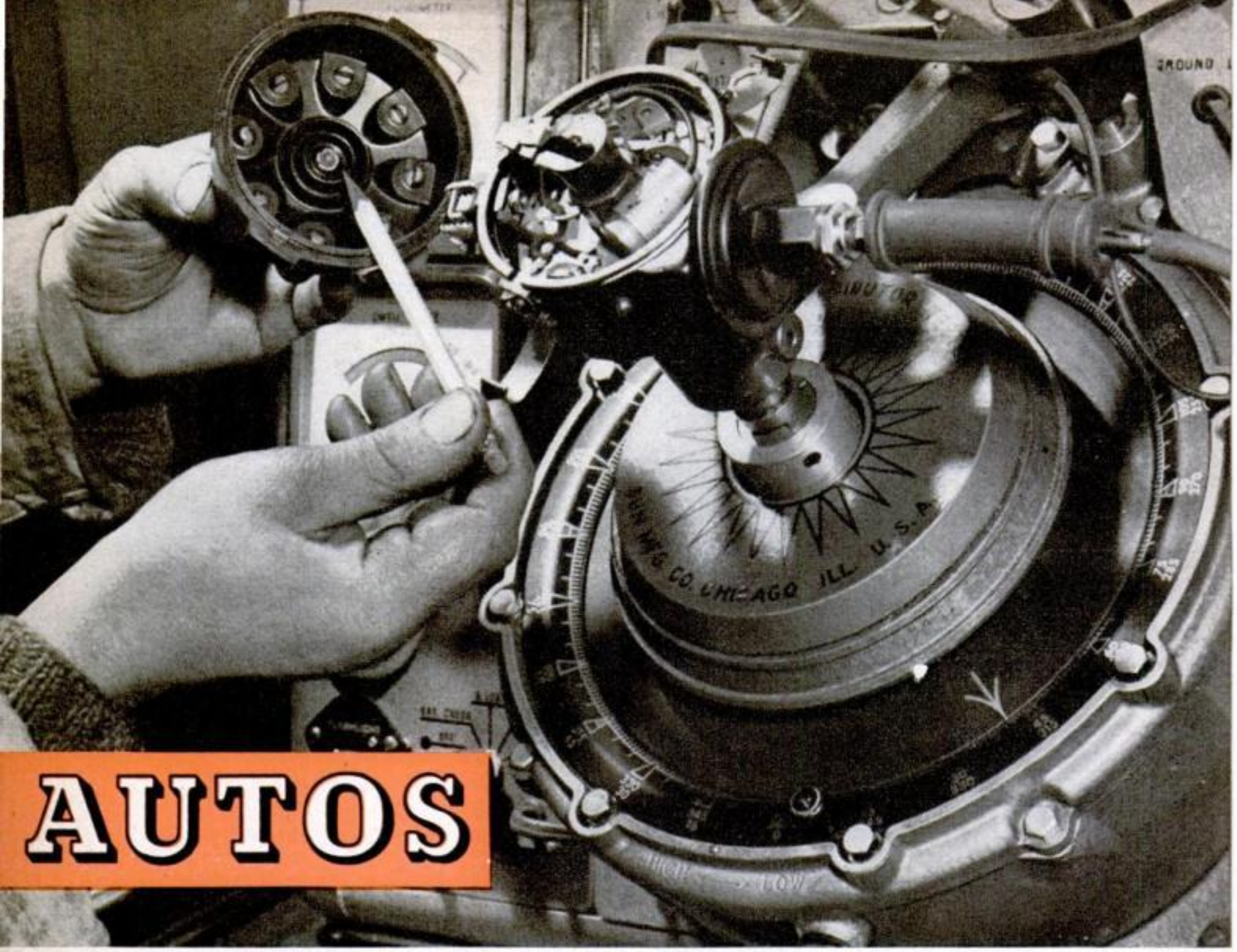

## Trailer-Bus of Plywood and Pressed Board for War Workers

CAPABLE of carrying 141 persons, a new 45-foot semitrailer bus has been built to transport industrial workers to and from war plants. Similar in looks to conventional highway freight trailers, the body is built of plywood and composition board, cutting to a minimum the use of critical war materials. Wooden benches seating four abreast run crosswise for the entire length of the trailer, leaving an aisle to the entrance at one side. Motive power can be supplied by a 1½-ton tractor. Experts of the Office of Defense Transportation expect the new trailer bus to help solve the problem of getting war workers to their plants without the use of private cars.

## Oxyacetylene-Torch Pack Helps Rescues in Tight Spots

TO HELP in the rescue of air-raid or disaster victims trapped by fallen steel girders and debris, a 96-pound oxyacetylene unit that can be strapped to a rescuer's back is now available. Its two tanks, smaller than those used in regular units, are mounted on a tubular cradle which can be carried on the operator's back by means of a special harness. The portable outfit can be speeded to the scene of disaster by car or motorcycle, and is compact enough to be carried into tight spots for close work in freeing persons pinned down by fallen material.

Packed on the back of a rescuer, this lightweight oxyacetylene torch can be carried over debris for cutting away a girder trapping a disaster victim




Precision adjustment of distributor parts is performed on this tester that puts the unit through its paces for the service man, analyzing its adjustment and automatic controls throughout the full speed range

# Keep 'Em Sparking!

## FACTS AND TIPS ON CAR IGNITION SYSTEMS

**By SCHUYLER VAN DUYNE**

MANY of us understand what a spark plug is and let it go at that. The remainder of a car's ignition system is a deep mystery compounded of efficient-looking plastic thingamajigs from which serpentine wires writhe every which way—somehow hooked up to a battery and a dashboard ignition lock.

Like other mysteries, this particular one is simple when you know the facts. Knowing them, too, will show motorists why an efficient ignition system will improve gasoline economy and engine performance.

A car ignition system is made up of—besides spark plugs—a coil, distributor, condenser, wires, and an electric supply (battery and generator). The job in hand is to deliver a perfectly timed surge of electricity across an open spark-plug gap in each cylinder at the exact moment when it will explode the cylinder's charge of compressed gasoline and air with maximum power efficiency.

It will help if we keep in mind that there are two circuits, the primary and secondary. The names derive from the coil which has two windings, primary and secondary, like a transformer. The primary winding consists of a few hundred turns of fairly heavy insulated wire. The secondary consists of many thousand turns of very fine insulated wire, usually inside of the primary coil. Inside this is an iron core. There are times when the secondary coil delivers an

18,000-volt wallop to the plugs of a normal car engine.

Look for a moment at one of the drawings (overpage) and follow the course of the battery current through the primary circuit. This will make it easier to understand the various parts to be described. It will be seen that current flows from the battery through the ignition switch, then the primary coil winding to a terminal on the distributor. From there the circuit divides, one path leading across the distributor breaker points, the other to the condenser. Both the base holding the points and the condenser are grounded, completing the circuit through to the ground terminal of the battery.

The condenser might be anywhere along the line between the coil terminal and the distributor terminal, but it is commonly placed in modern cars underneath the distributor cap where it is well protected from dirt and moisture.

The condenser is nothing more than two long strips of metal foil separated by thin paper and rolled up in a metal case. One strip is connected to the case, the other to the protruding pigtail wire. When the distributor points separate, current will continue to flow momentarily into the condenser. Wasteful arcing of current across the points is prevented, saving the current for more useful ends, of which more later.

The distributor may be likened to a two-story switch house in which currents of the primary circuit just described flow through the mechanism on the first floor. The switching machinery of both floors, however, is operated by a single shaft running up through the middle of both. This shaft is driven by gears at half the speed of the engine crankshaft.

The switch on the first floor is the insulated, spring-loaded breaker arm. On a typical eight-cylinder engine, this arm has a fiber rubbing block located so as to contact an eight-sided cam on the distributor shaft. As the cam revolves, its corners push the rubbing block aside, opening and closing the distributor points four times for each revolution of the engine crankshaft.

Upstairs, meanwhile, the distributor shaft is turning a small plastic arm, called the rotor, fitted to its top. Above this, in the center of the removable plastic distributor cap, is a small button of carbon. A springy strip of metal running across the top of the rotor presses against the button at all times. The other end of the strip swings with the rotor past eight metal buttons. The buttons are connected by wires to the spark plugs. A high-tension current impressed through the secondary circuit will leap across the space between the rotor and the nearest distributor-cap button.

How this secondary current, which we

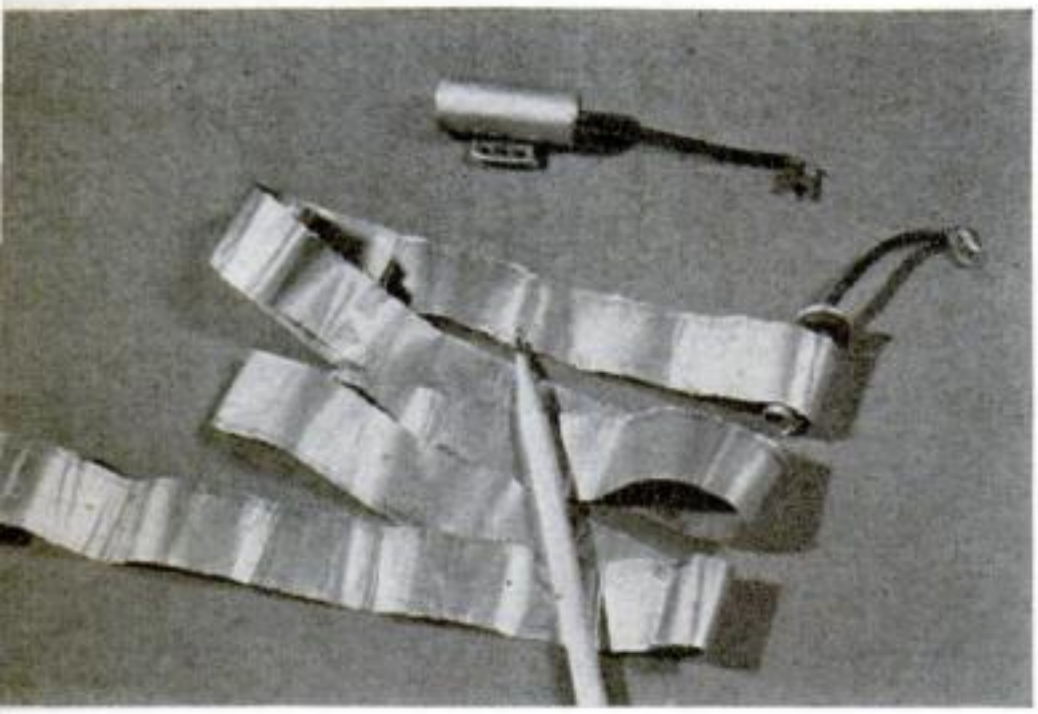
**The wise motorist will familiarize himself with the distributors shown below. At right is a common type, shown in close-up with its head and rotor removed. Another common type, of simpler construction, is detailed in the drawing. If you know the functions of the various parts, you are better equipped to spot their trouble symptoms**






The upper part, or cap, of a distributor is plastic. The lower (right) is metal

Here an actual trial is being run on a distributor with a testing machine. Neon lights flash on the circle marked in degrees as sparks occur, aiding adjustment. It also tests points, condenser, and spark quality



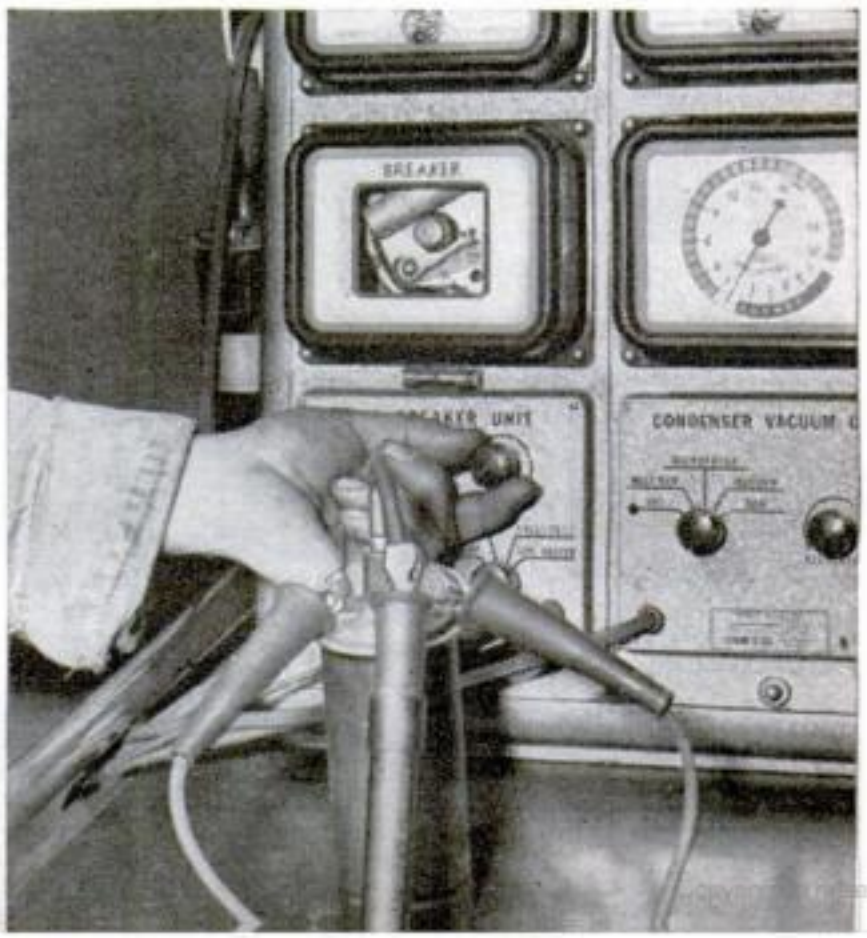
A condenser is just two long ribbons of insulated, rolled-up foil. In dead, unrolled unit above, the pencil points to a hole burned by a jumping spark

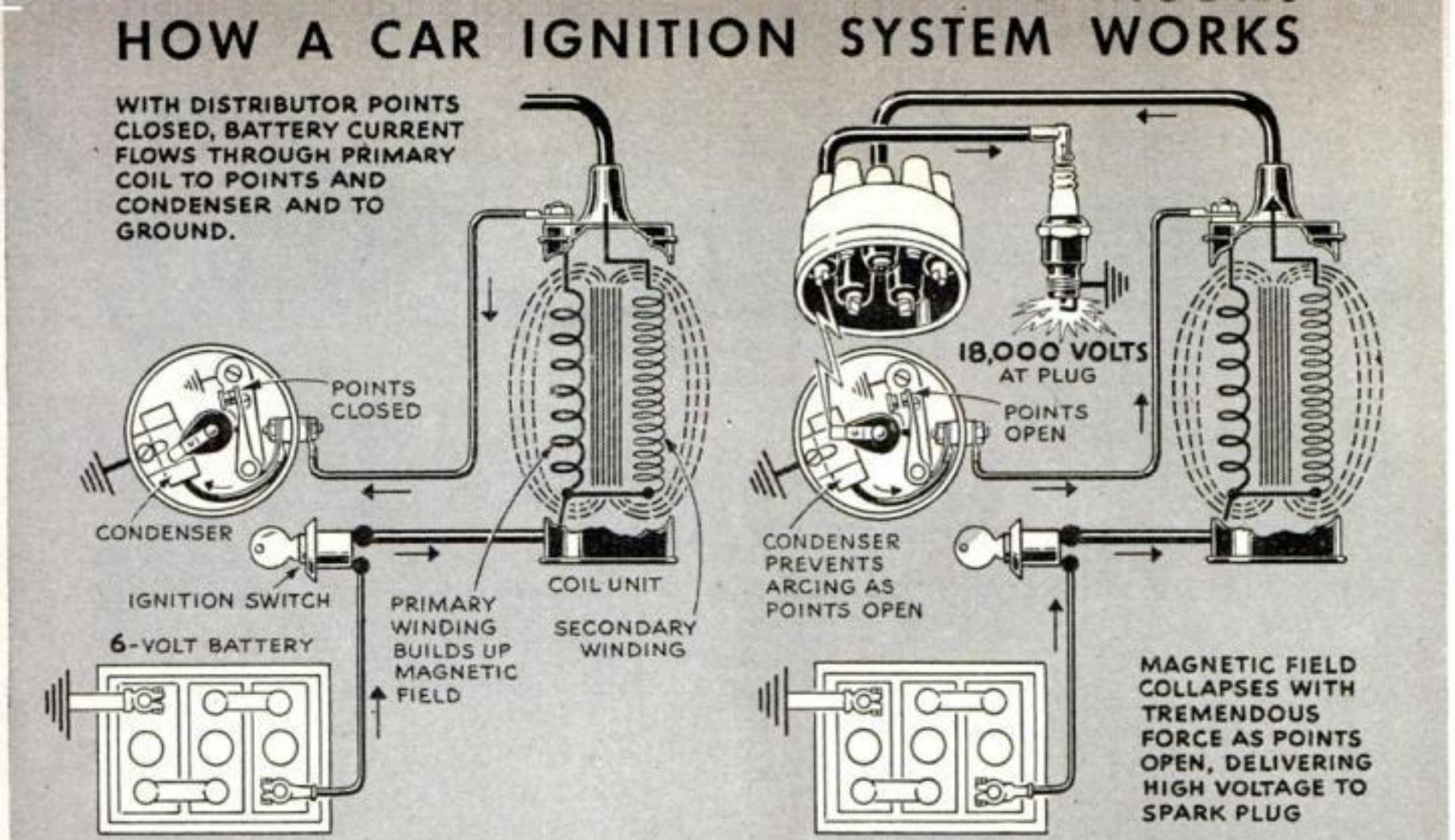
have seen may go as high as 18,000 volts, is created out of an initial current of six volts from the storage battery is worth investigating. While the distributor points are closed, we observed that current flows through the primary winding. This creates a magnetic field in the coil which takes a brief time to reach its maximum. As it builds up, the magnetism produces a counter-voltage in the winding which figuratively bucks against the battery voltage.

Peak possible value of this magnetic force is determined by the time that the points are closed, and the resistance of the primary coil. When the points open, the condenser momentarily absorbs the current, bringing it to a controlled stop, and preventing destructive arcing at the points.


SPARK PLUGS, left, often last upwards of 10,000 miles, but it takes care. Here the plug is being sand-blasted in a special machine to remove carbon. Adjustment of the gap follows

COILS too are long-lived. But they don't always fail suddenly as might be expected. Special testers diagnose incipient failure, and wiping off dirt and keeping them dry are their best tonics






The pair of drawings above show the primary and secondary circuits of a typical ignition system. Careful study here will reward the reader. Note that spark is generated as rotor passes each plug contact

A sudden sharp collapse of the magnetic field induces high voltages in both the primary and secondary windings. These voltages are proportional to the relative number of turns in the windings. Our primary-winding voltage may go as high as 180 and our secondary as high as 18,000.

Instead of being used up in an arc at the points, this enormous voltage flows through the high-tension terminal and wire to the center of the distributor cap, continuing, as the diagram shows, to the proper spark plug. There it jumps the spark-plug gap to complete the circuit to ground, igniting the charge in the cylinder.

The whole process, from the opening of the distributor points to the occurrence of the spark at the plug, takes about one 40,000th of a second. Thus it is possible to time the spark very accurately for any desired point of engine-piston travel.

It happens that in automobile engines this is a variable point. At high engine speed it is well before the piston reaches the top of its compression stroke. At lower speeds it is close to the top of the stroke. Proper adjustment of the spark to the needs of the cylinders is accomplished automatically by weights on the spinning distributor shaft which swing the distributor cam and rotor slightly ahead as the shaft speed increases, "advancing" the spark the needed amount.

But there is further need for timing change during normal driving, as when a car is running at partly opened throttle. There is then a vacuum in the intake manifold and the charge reaching the cylinder is not so highly compressed. An additional spark advance would then increase economy.

The manifold vacuum itself is used to effect this advance, through a pipe leading from the carburetor to a spring-loaded diaphragm connected to a link that can turn the distributor housing slightly. A change of spark timing is thus obtained automatically as manifold vacuum changes. On some distributors, the plate holding the breaker points is moved by this linkage, instead of the entire distributor housing, accomplishing the same purpose.

Spark plugs are the gun barrels that shoot the high-tension spark to the proper place. When one wears out or breaks, replacement is the best remedy. When new, and occasionally during their life, their gaps must be adjusted to the car maker's specifications, and plugs should be kept clean inside and out to prevent spark leaks that cause improper fuel combustion and missing.

Quick checks of all ignition-system parts are not possible without special apparatus requiring skilled workmen. The average motorist using a good feeler gauge can adjust spark-plug gaps. Serious distributor point misadjustment can be partially corrected with a gauge. It should be remembered, however, that proper spring tension against the hinged breaker point, as well as the exact cam angle at which points open and close, are critical and almost impossible

to measure without proper tools and technique.

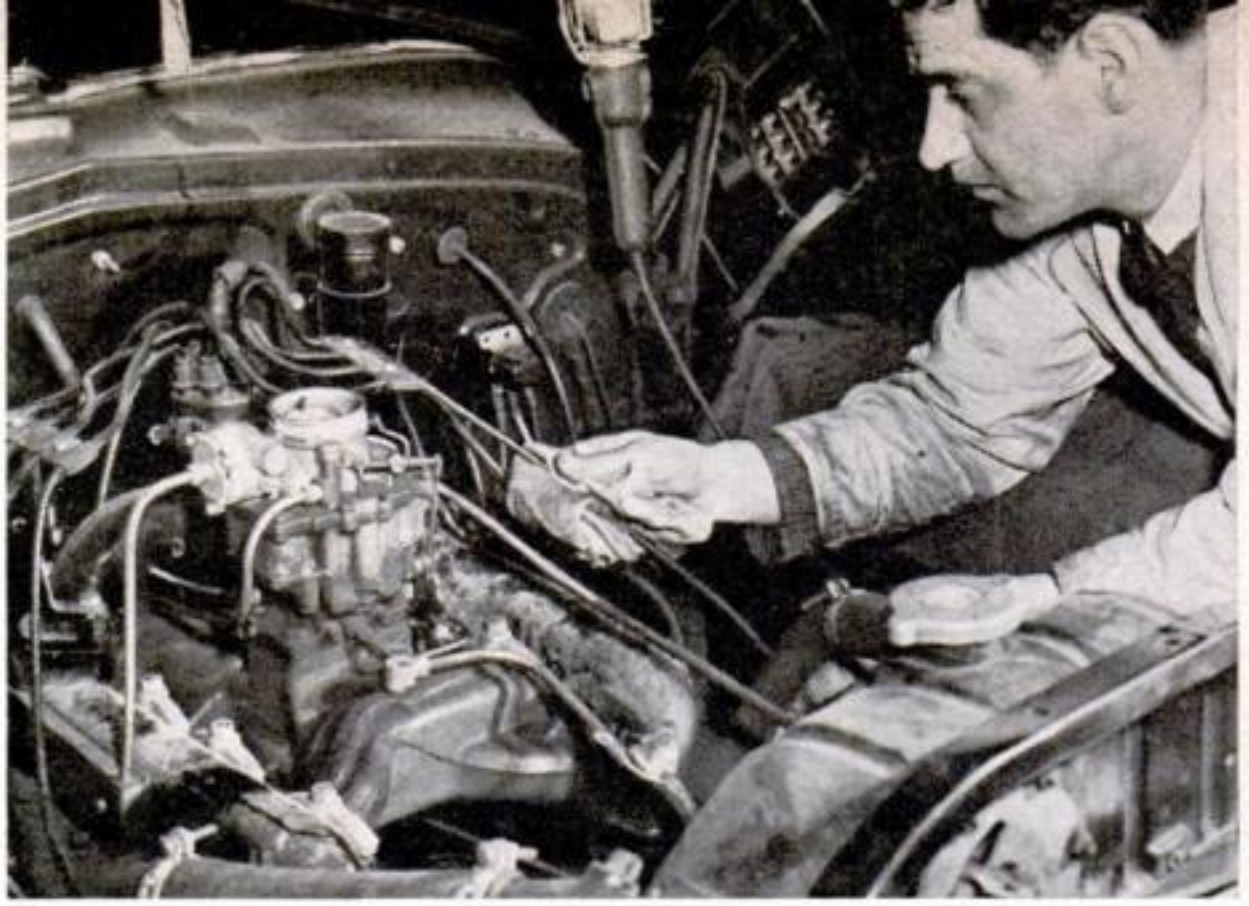
Careful inspection of the points can pay dividends once you have determined which way the current flows through them. Study of your car owner's manual will settle this. You may well disregard any minor pitting of the tungsten points, but if one point shows definite build-up in size, there are several simple remedies. If it is the positive point, the condenser may be of too low capacity, the high and low-tension wires running from the coil to the distributor may be too close together or too far from ground (the engine block or other metallic part of the car), or the condenser lead may be too long. Corrections are simple. Moreover, if it is the negative point that shows build-up, remedies are the reverse of those given for positive-point build-up.

An ingenious reversing switch connected to the starter linkage of some recent cars changes the direction of the current through the distributor points each time the engine is started so that build-up never makes headway on either point.

If points become burned, a battery-terminal clamp may be loose, a battery wire weak or broken, or the voltage regulator out of whack so that too much voltage is reaching the ignition system from the generator.

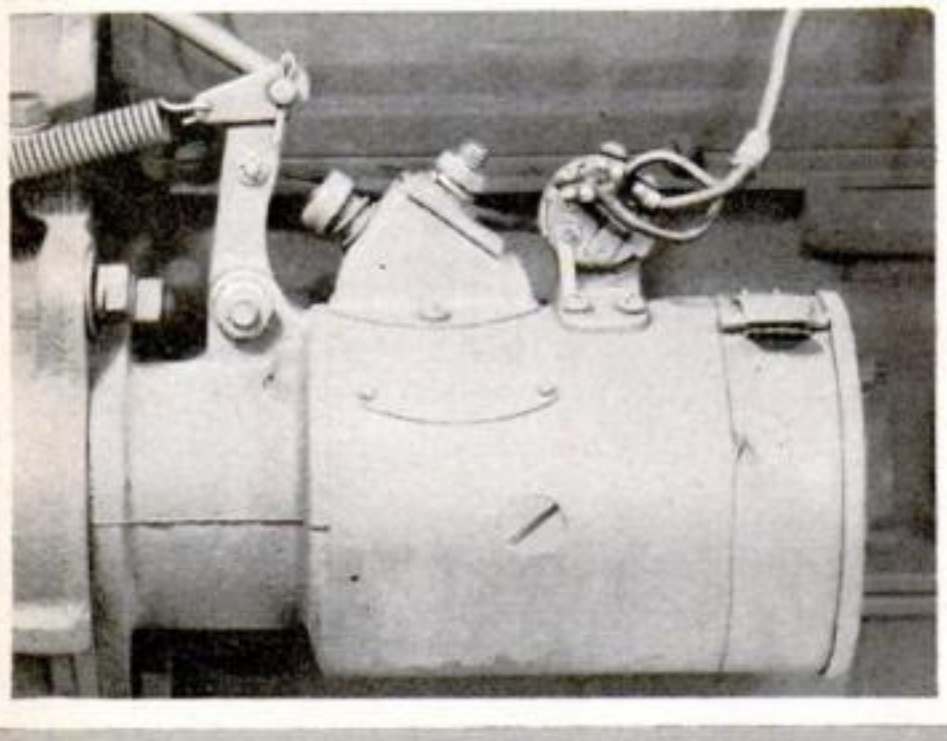
All exposed wires and parts should be wiped clean frequently. Coil, condenser, and most other ignition troubles need an expert to locate and remedy. Loose or frayed wires should be tightened or replaced. A touch of petroleum jelly should be applied occasionally to the distributor rubbing block, and a spot of oil to the pad under the rotor.

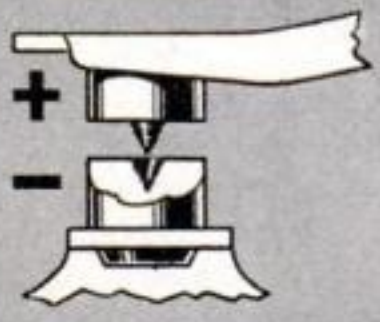
Keep in mind that the three enemies of an ignition system are wear, weather, and neglect, if you want to keep 'em sparking!



An important part of ignition-system care is a thorough and frequent wiping and tightening of the exposed wiring. If insulation appears to be cracked or dry, or if any frayed wires are seen, replace the wires

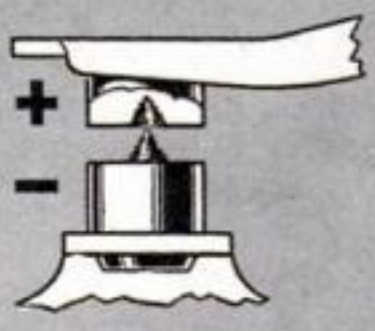
## IMPORTANT FACTS OF DISTRIBUTOR-POINT WEAR

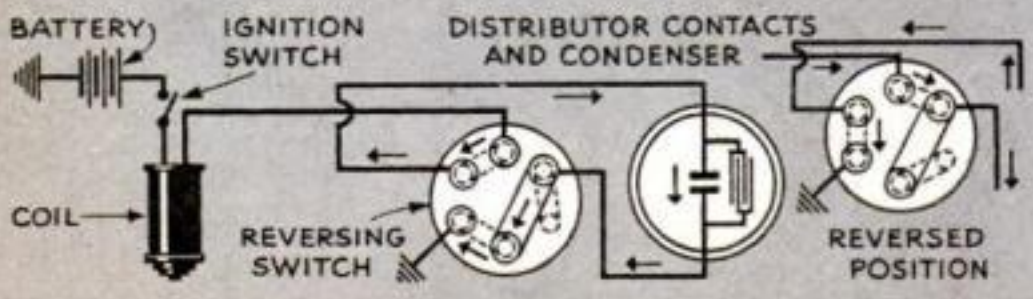





If the positive point builds up, condenser may be undercapacity, coil leads to distributor too close together and far from ground, condenser lead too long

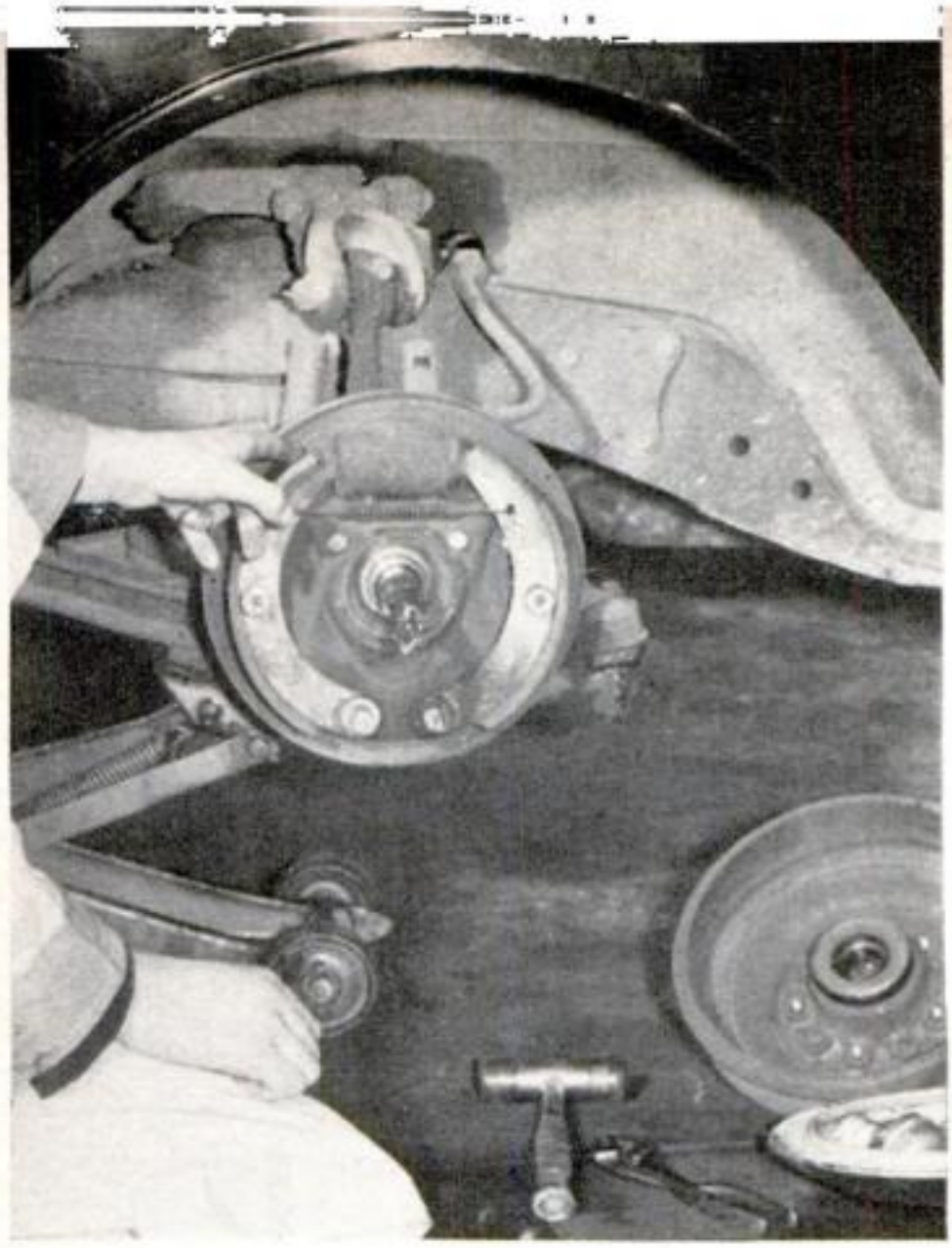
If build-up is on negative point, move coil leads closer together and away from ground, lengthen the condenser lead, or substitute lower capacity condenser



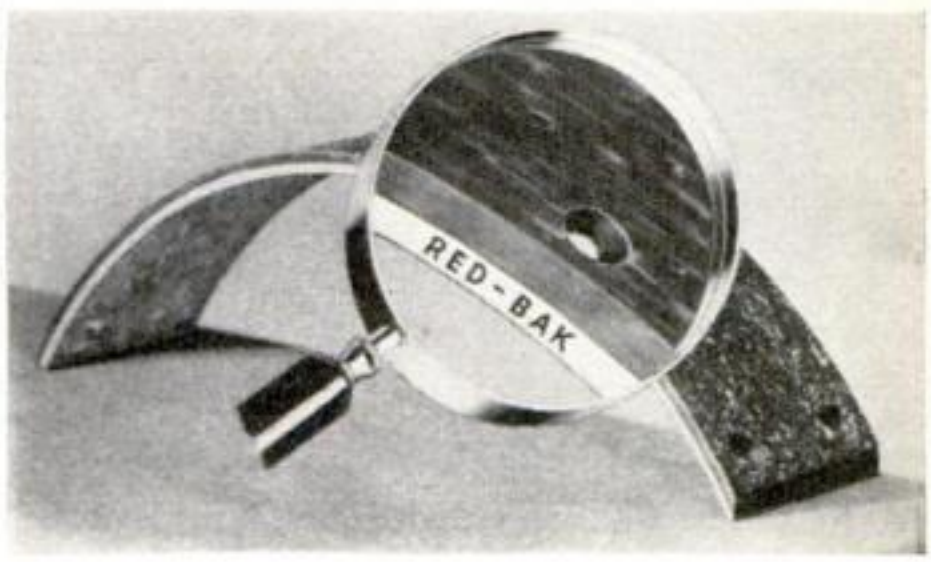

A reversing switch (inset and diagram at left) connected to the starter pedal of some cars reverses the current flow across the points as shown. Thus any build-up on the points is reversed periodically, never becoming very great

# Auto Ideas



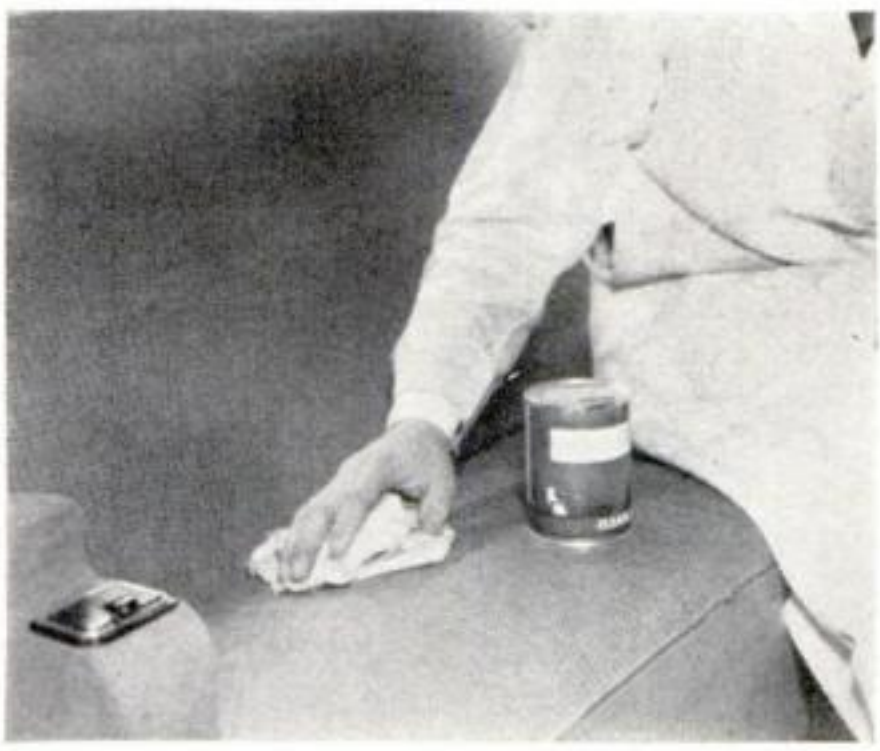
With wheel removed, above, the red backing of the brake lining will show when the surface is worn to the danger point. In cross-section, right, is a sample of the two-colored lining material

**BRAKE LININGS THAT WARN** when they should be replaced mark a recent advance in motoring safeguards. The lining material is backed by a layer of red material which extends just beyond the depth at which the rivet heads are sunk. If, upon removing a wheel for brake inspection, any red appears on the braking surface that contacts the brake drum, it indicates that the lining is worn down beyond the point where safe stopping of the car is still possible.

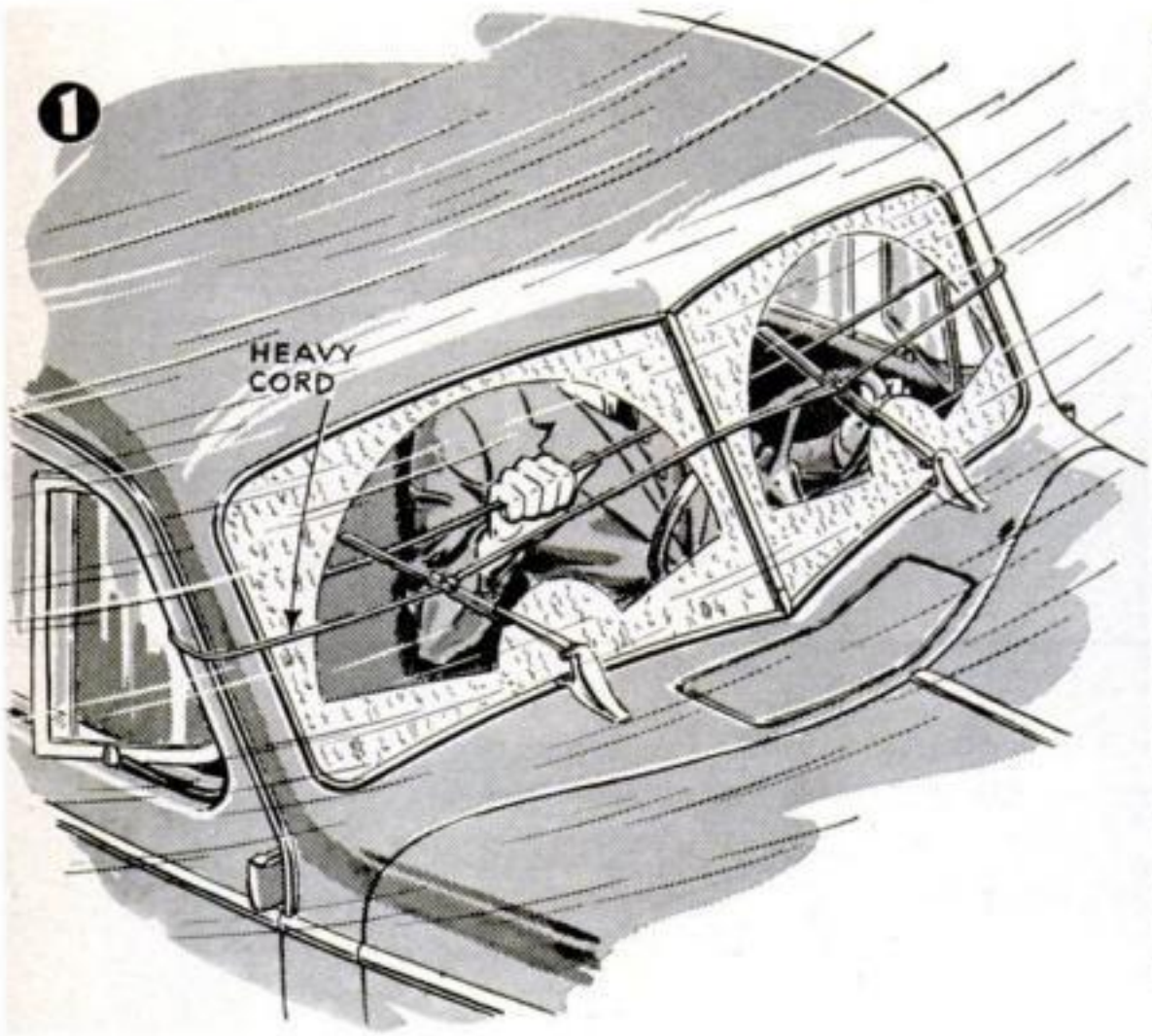


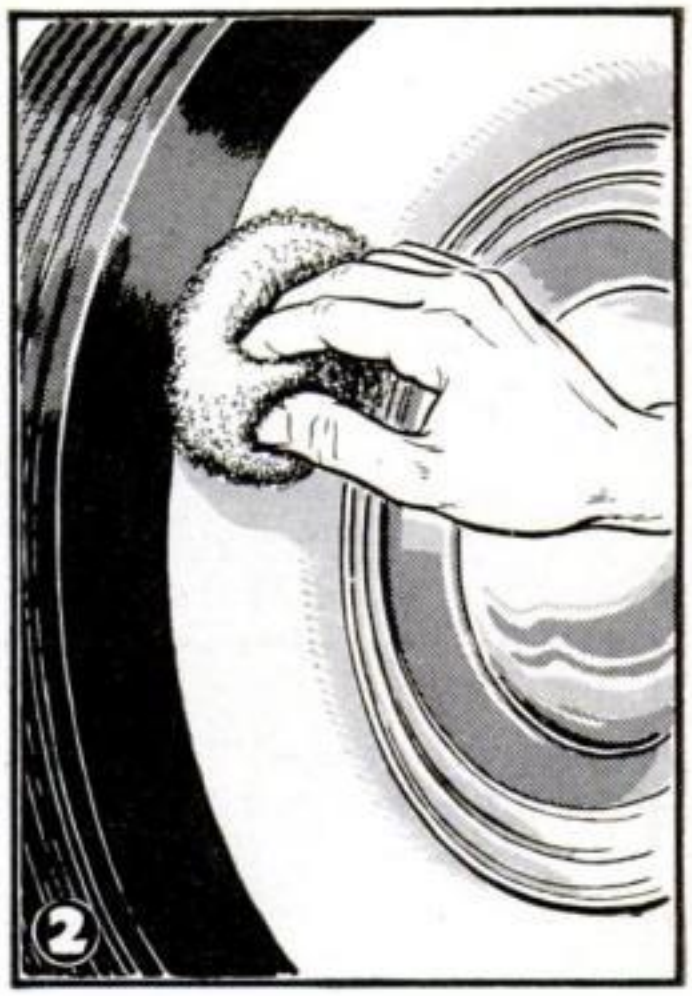

**AN AUTO-UPHOLSTERY CLEANER** that can be used as a spot remover or an all-over shampooing fluid is said to have a color-brightening effect on automobile fabrics rather than any fading effect, and in addition leaves the car interior with a clean, agreeable odor. The maker states that the product is harmless to the hands of the user. It is put up in cans like that shown in use below, or may be had in quantity lots in one-gallon bottles for commercial use.

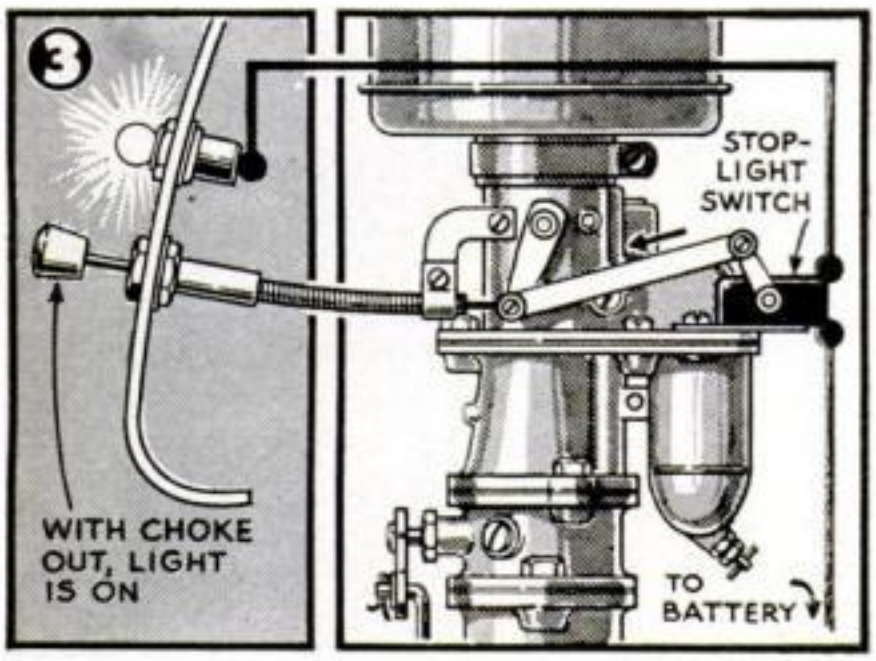
**SPECIAL BLACKOUT LAMPS** for use as tail, marker, or clearance lamps on trucks and cars have just been marketed. With convenient brackets for mounting, the lights have lens assemblies consisting of a single unit 2½ inches in diameter with dead-black metal louvres, outer plastic lens, and inner color filter, all in one. Their visibility is 600 feet on a level, zero to planes in the air. The lens can be turned to fit the angle of installation.



# EIGHT USEFUL IDEAS

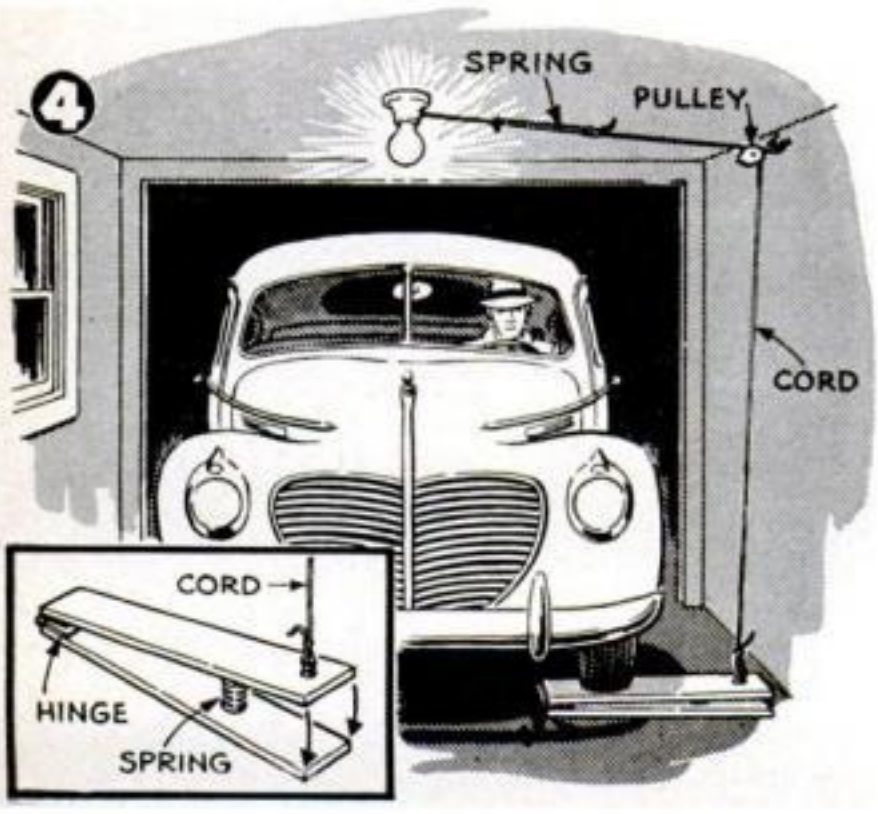



**1** **WINDSHIELD WIPERS** that fail may be operated in emergencies with the rig shown. Simply loop a heavy cord through the door windows entirely around the shield. If the wipers are mechanically coupled to work together, only one wiper blade should be tied to the cord. Leaving the front windows slightly open, you can operate the blades by hand from inside the car.—J.R.

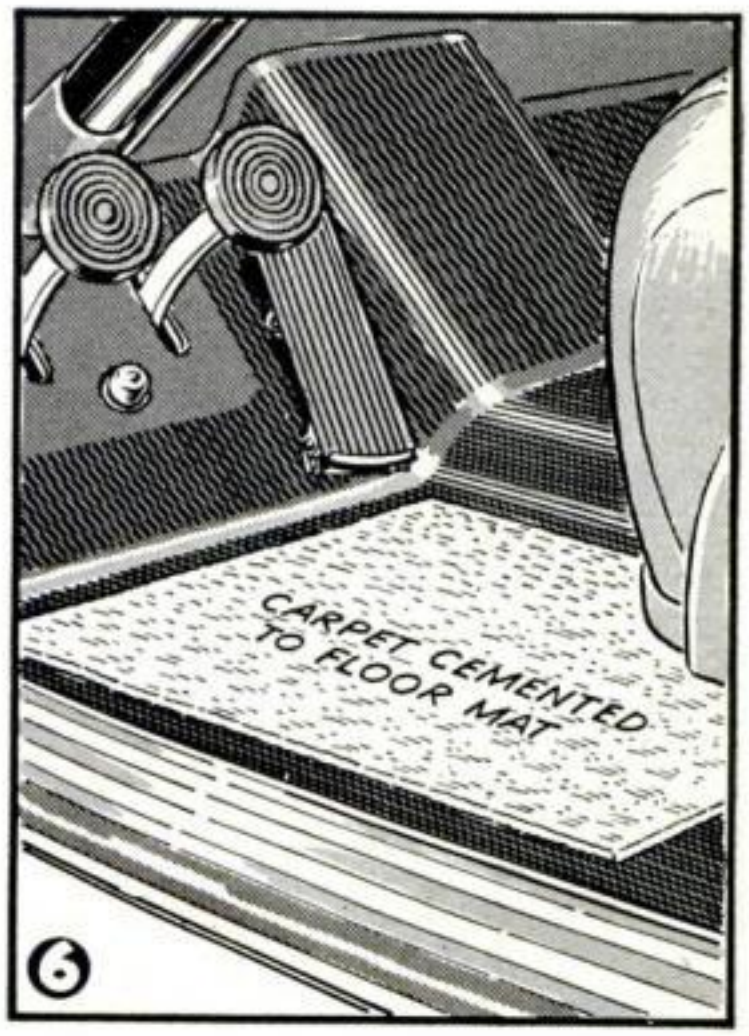
**2** **STEEL-WOOL SCOURING PADS** of the kitchen variety, impregnated with soap, are excellent for cleaning white-sidewall tires. Wet the tire and pad and rub the walls gently. Too-energetic treatment should be avoided, and the tires should be thoroughly rinsed with water to remove the soapsuds.—V.S.




**3** **A CHOKE-BUTTON WARNING LIGHT** that gleams on your dashboard whenever the choke button is out will help prevent wasting gas. Mount a stop-light switch on or near your carburetor, coupled to the choke lever as shown, and wired with a good-quality insulated wire. Various types of stop-light switches and warning-light sockets are obtainable at auto-accessory stores.—W.P.

**4** **AUTOMATICALLY LIGHTING YOUR GARAGE** as you drive in, the treadle switch shown is easily made from two hinged boards, two coil springs, and string. Set the switch well inside the garage so that only the front car wheels pass over it. Before backing out, light the light by hand or foot.—J.C.J.

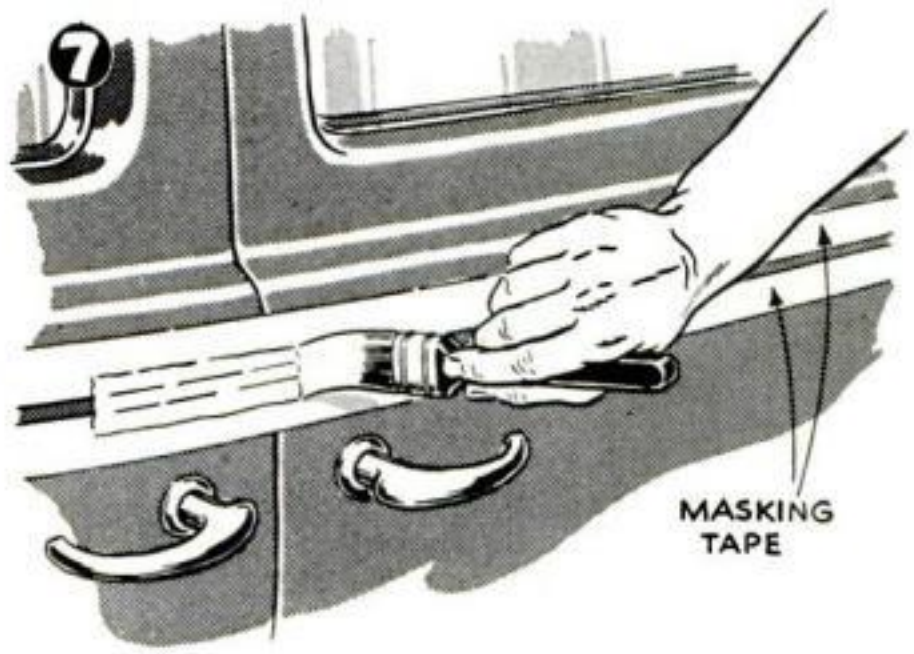
# FOR THE CAR OWNER


DRAWINGS BY STEWART ROUSE

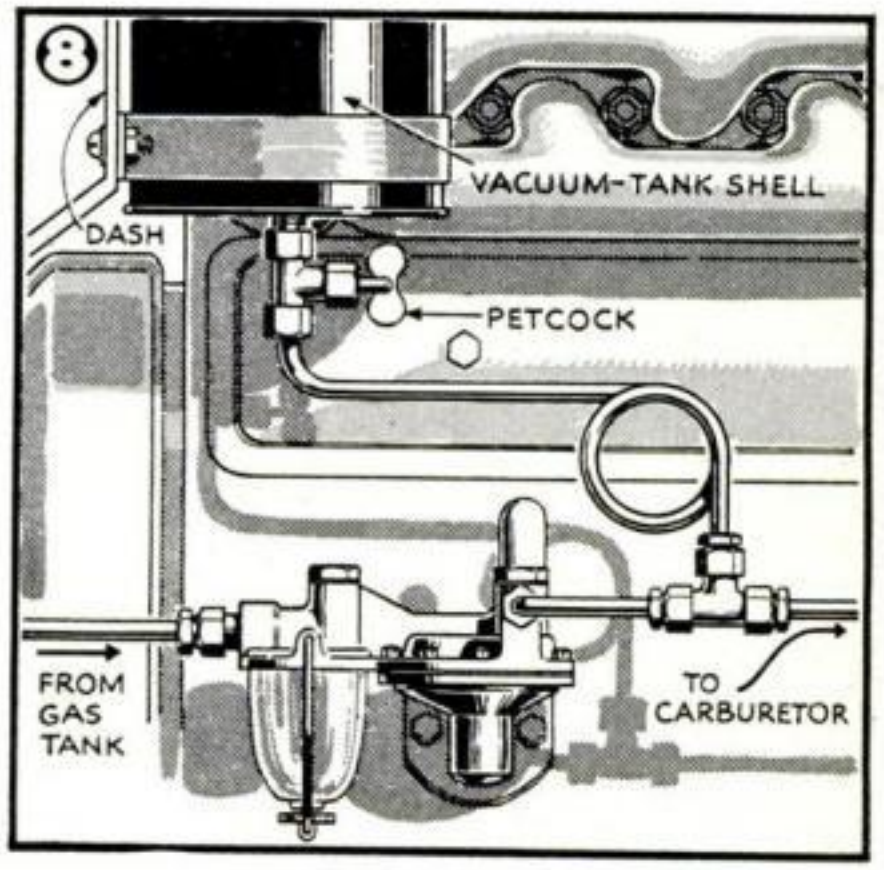
**5 A REAR-VIEW MIRROR** that can be aimed through a wide angle without putting your hand outside the car is afforded by cementing a small pocket-size mirror to the ventilator window at the left of the driver's seat. Set at eye level, it is turned by moving the window in or out. A good china-mending cement will hold it tight.—V.L.

**6 TO LENGTHEN THE LIFE** of rubber floor mats, or to cover up worn spots, a piece cut from an old carpet to the desired size and shape makes a soft, easily cleaned cover for the car floor. Wash the rubber mat clean before attaching the carpet by means of household rubber cement.—H.J.S.




**7 REPAINTING THE STRIPES** on your car is greatly simplified by the use of painters' or artists' masking tape. Available with an adhesive back at most hardware stores, the tape is placed on each side of the area to be refinished. Paint the area, letting some paint get on the tape, and remove the tape before the paint is fully dry.—J.R.R.

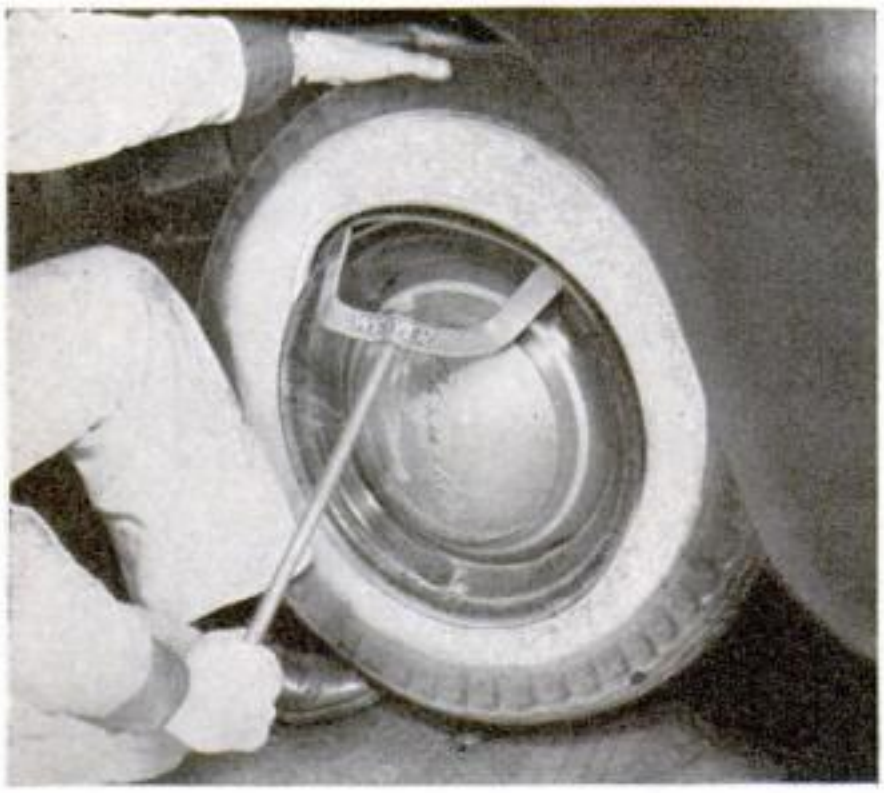
**8 A RESERVE GAS TANK** made from an old-fashioned vacuum tank can easily be attached to the cowl under your engine hood. The supply tube, with a good-size loop to allow for vibration, should be connected to the carburetor side of the fuel-pump line. The tank should be above the float level of your carburetor, and equipped with a petcock for controlling the flow.—E.G.G.



# Auto Ideas

**EMERGENCY HIGHWAY-ROUTE MARKERS** of distinctive size, shape, and lettering now identify secondary highways for civilian motorists in New York City and neighboring areas. Sponsored by the Metropolitan Defense Transport Committee of New York and erected by state highway departments of New York, New Jersey, and Connecticut, the uniform signs are to guide civilians in the event that main routes are required for military use. The new markers, with black letters on white backgrounds, are related to existing highway marking schemes wherever possible. For example, Civil Route No. 501 parallels U. S. No. 1; Civil Route 532 is an extension of New York Route 32 into New Jersey, and all civil routes are marked in the 500's. Gasoline-company maps are identifying the new civilian routes. A typical sign installation is shown in the illustration at the left.


**A NEW BURGLAR ALARM FOR CARS** blows the horn intermittently when the car is molested. Attached to the engine fire wall under the hood, the mechanism incorporates an ingenious switch that closes when moved. The amount of movement needed can be predetermined by setting an adjustment screw. Connected to the horn circuit and also to a dashboard switch, the unit is turned on when the driver leaves his car. It may be adjusted so that careful opening of the door on his return will not set it off, and it is operative regardless of the angle at which the car is parked, the manufacturer claims. The alarm takes only a few minutes to install.

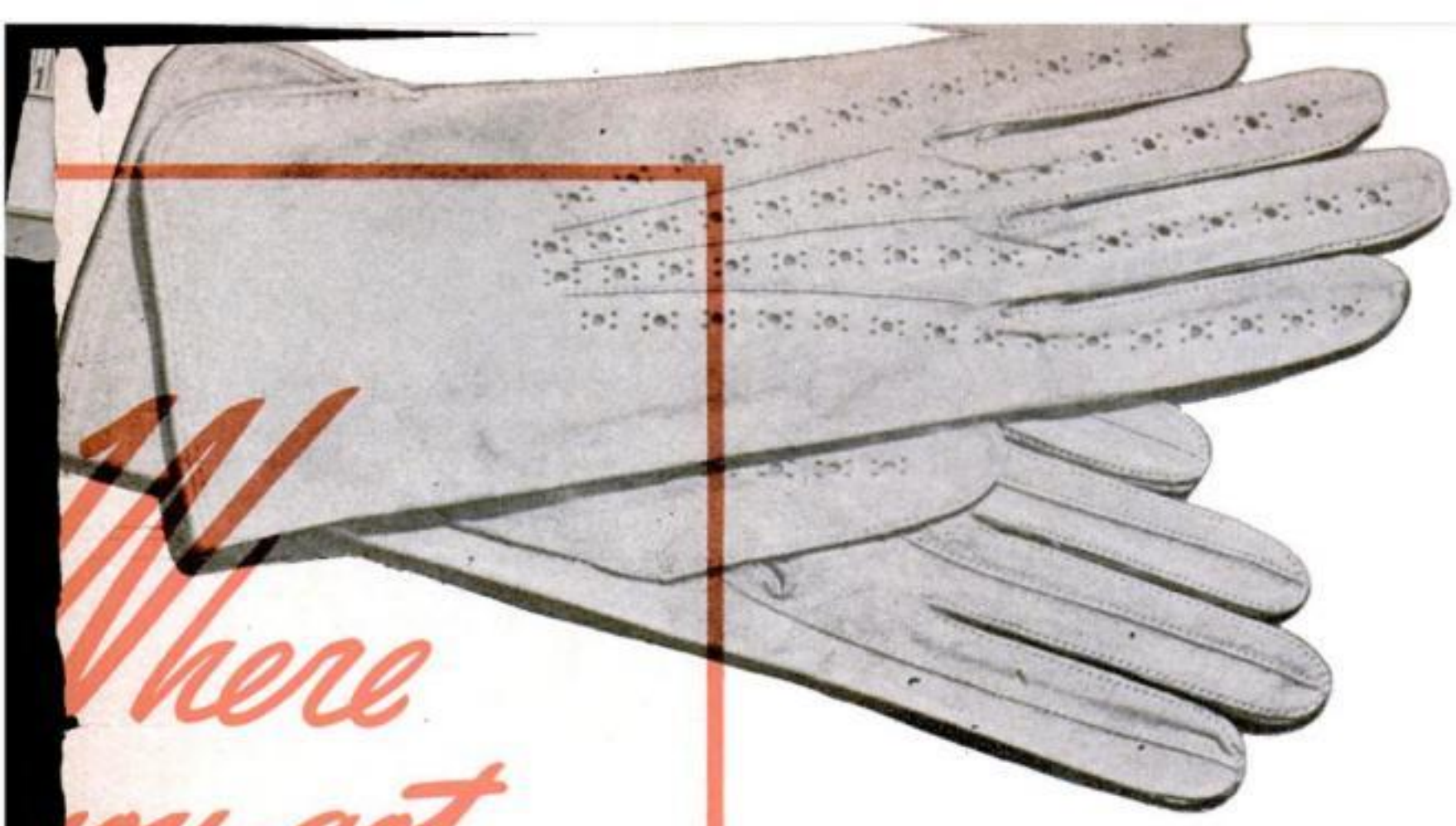
**WITH THE FORK-TYPE TIRE IRON** illustrated in use at the left, that takes the place of ordinary tire irons, a mechanic is said to have an easier job of removing tires from rims. Tube-pinching dangers are greatly reduced, moreover, since after the tire bead is free, the inner tube may be watched by the operator until the casing is completely off the wheel. Designed for use with a wheel on the vehicle or on the floor, the tool is of solid welded construction and removes tires from all types of drop-center rims without marring the wheel rim or scuffing the tire beads, including drop-center rims with "safety" ridges that grip the beads in event of a blowout. It is made of tempered spring steel with a cold-rolled steel handle. Its approximate weight is three pounds.

# Sikorsky Helicopter Streamlined

Greatly simplified in design, the new Vought-Sikorsky helicopter has two rotors and a covered fuselag

STREAMLINED and simplified, a Vought-Sikorsky helicopter of improved design has just been announced. Its forerunner, an experimental model tried out early last year at Stratford, Conn., established a world endurance record for aircraft of this type. Piloted by Igor Sikorsky, noted aeronautical engineer, it remained aloft for one hour and 32½ minutes, sustained and guided by four whirling rotors. The new type reduces the number of rotors to two, permitting much simpler control mechanism. Addition of a covered fuselage reduces air resistance and increases the comfort of the pilot. Only now approaching the practical stage, helicopters are distinguished from other aircraft by their ability to rise and descend vertically, and to hover motionless in the air—an asset for military observation—as well as fly horizontally. A flat roof top, or a ground area little larger than the machine, would serve as a landing field, enabling helicopters to alight in congested city areas.

This is the experimental VS-300, photographed duri
record-breaking endurance flight made on April

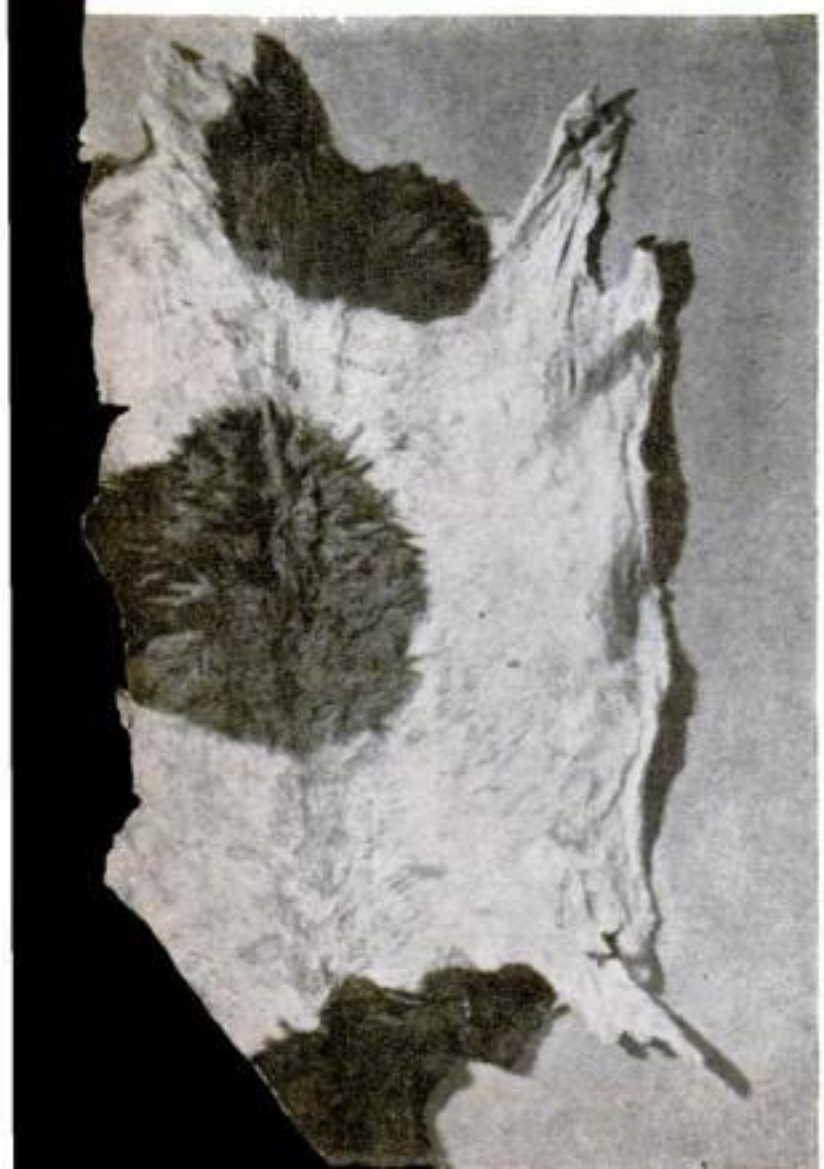


# Where you got those gloves

## RETS OF AN ANCIENT ART SED FROM FATHER TO SON ULTON COUNTY, NEW YORK, CENTER OF AMERICA'S GLOVE-MAKING INDUSTRY

By HERBERT ASBURY

SINCE no leather glove is better than its tannage, the story of glove making properly begins in the tannery. When a raw skin is received at a tanning mill which specializes in glove leather, it is one of a consignment of from 100 to 800, closely packed in a bale. It has been sprayed with naphthalene to discourage insects; it is on the verge of putrefaction and smells to heaven; and it is either dry, stiff and horny, or wet, slippery and rubbery, depending upon whether it has been dry-salted or pickled at the point of shipment. When it leaves the tanner's hands, dyed and finished according to manufacturing requirements, it is as pliable as a sheet of rubber and as



**TANNING** Skins for making fine leather gloves reach the tanning mill in the condition shown at the left, in bales of 100 to 800. When they leave, dyed and finished, they are soft and smooth like the one below. About two thirds of the best gloves made in this country are of capeskin

soft as the skin of a baby. From it an American manufacturer will make a glove superior in most respects to the best product of prewar France.

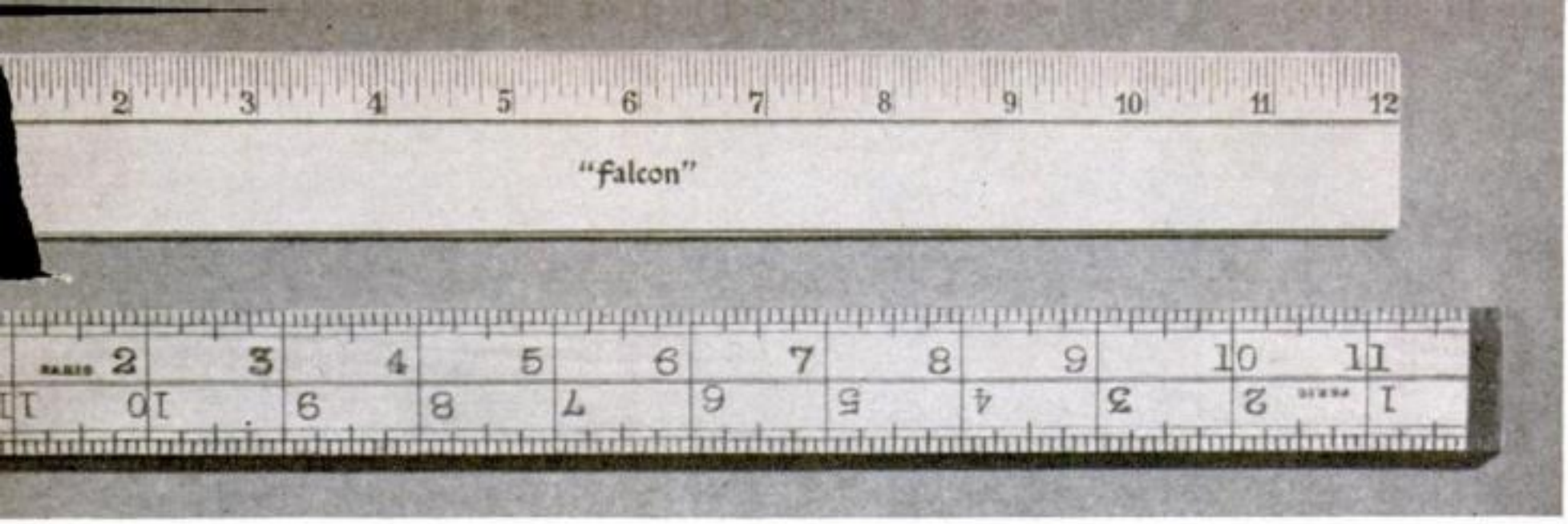
The skin may have been taken from any one of a dozen animals. If your glove is a work glove, or a cheap dress glove with no particular style and only approximate fit, it probably came from the hide of a horse, a calf, a reindeer, a dog, a domestic wool sheep, or a common pig. But if it is a fine table-cut glove, fairly expensive, styled in the latest fashion, and fitting snugly yet allowing every normal movement of the hand, the chances are it once helped cover the back of a haired sheep, a goat, a lamb, a deer, a wild hog, or a kid, none of a species native to the United States.

The primary object in tanning leather, probably mankind's oldest manufacturing industry, is to so soften and separate the fibers that the skin will not putrefy, that it will withstand moisture, and that it will stretch easily without springing back. Fine glove leather, in addition, must be given a soft, attractive and durable finish. The methods chiefly used in the United States are the chrome, which employs chrome salts; the alum, in which the tanning agent is a mixture of alum, salt, egg yolk, and other substances; and the oil, used especially to produce such soft leathers as chamois and buckskin, in which the skins are processed with fish oil. Chrome and oil-tanned leathers are washable, while those tanned with alum are not. All capeskin leather, from which some two thirds of the country's fine gloves are made, is chrome-tanned.

The principal plants which employ these tannages, and the most important fine-glove factories as well, are located at Gloversville and Johnstown, in Fulton County, New York. This county has been the center of the glove industry since colonial times, when several families of glovers from Perth, Scotland, were settled there. Today Fulton County produces approximately 90 percent of America's glove leather and about 70 percent of its fine gloves.

The finishing of chrome-tanned leather is done by a process called staking, in which the skins are manipulated until they are soft and velvety. Heavier skins are usually staked on a machine, but capeskin and most of the

**STAKING** Chrome-tanned leather is finished by staking. A skilled operator throws the skin over a post with a curved blade at the top and works it back and forth, flesh side down, using his knee for leverage

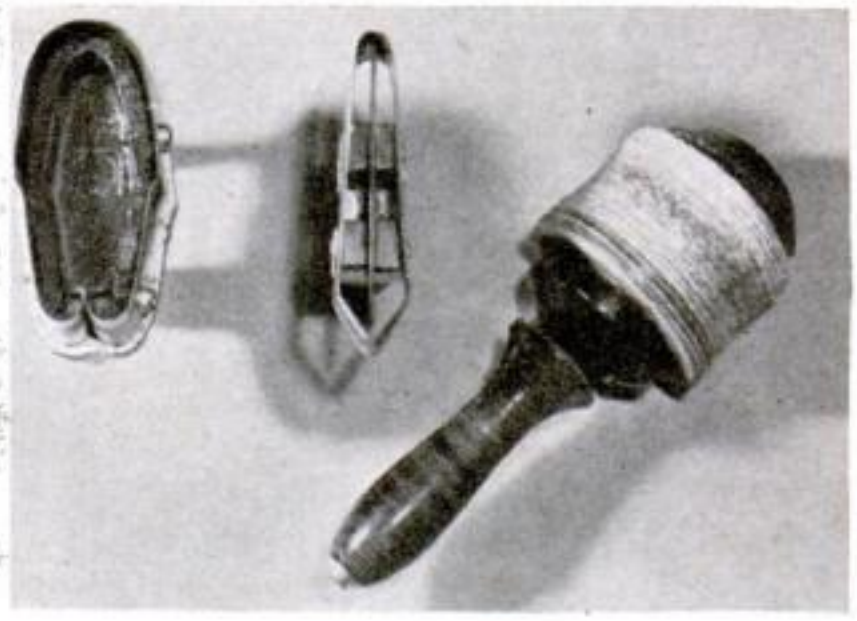



## EQUIPMENT

FRENCH RULE. The table cutter, aristocrat of glovers, makes his delicate measurements with a French rule 12¾ inches long. These photographs were made at the factory of the Hilts-Willard Glove Corporation in Gloversville, N.Y.


STEEL DIES or patterns are used in cutting the thumbs and the fourchettes, the small oblong pieces between the fingers. Five sizes of dies for thumbs and three for fourchettes, for both men's and women's gloves, are employed in most factories. The piece of leather is laid over the sharp edges of the pattern and pounded with a mallet. At the right are shown a thumb and a fourchette pattern, along with the mallet

SHEARS AND SPUD KNIFE are other tools of the cutter. His main stock in trade is his skill, strength, and wide knowledge of leather



other fine leathers are knee-staked. This highly skilled labor is performed on a wooden post about three feet high, into the top of which a large, blunt, convex blade has been fitted. The operator throws the skin over the blade, flesh side down. He then grasps opposite edges of the leather, presses his bare knee against it, and draws it firmly back and forth over the blade.

After the skin has been staked the grain is polished on a plush wheel and the leather is ready to be made into gloves, a manufacturing process which involves from 26 to 30 handlings and seven main operations by skilled workmen.

When a skin is received at the factory it is graded, inspected, and measured in all dimensions with special gauges by the foreman of the cutting room, who must be an expert on leather. It is then put on an abrading machine which takes it down to the required weight and thickness, and when this has been done the skin goes to the cutter. Three principal methods of glove cutting are used in American cutting—table cutting, for fine gloves; pattern or pull-down

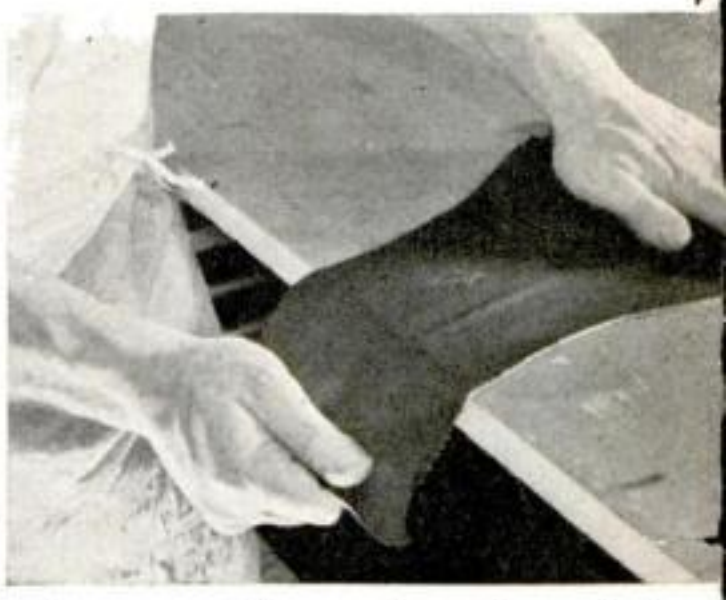
cutting, for good but less expensive gloves, in which the sections of a skin are cut off and then pulled down to fit a pattern; and block cutting, for cheap gloves and work gloves, especially those made from heavy skins. Block-cut gloves are simply punched out on a die, which is placed on the leather and struck with a heavy maul.

The table cutter's tools are a large pair of shears, a spud knife, and a French rule 12¾ inches long. An English foot rule would serve just as well, but the use of a French rule is a trade custom dating back to the days when glove cutting was almost exclusively a French occupation. With these implements an expert can cut about three dozen pairs of gloves a day. What he actually does is to cut a skin into oblong pieces called tranks. But to perform this apparently simple operation requires considerable strength, skill of an extremely high order, and a thorough knowledge of leather. Upon the ability of the table cutter depends almost entirely the fit, and consequently the salability, of a pair of fine gloves. There is a tradition in Gloversville that a table cutter must be the son of a table cutter, and this tradition is maintained to an astonishing degree. There are families in Fulton County of which for many generations the eldest sons have been table cutters.

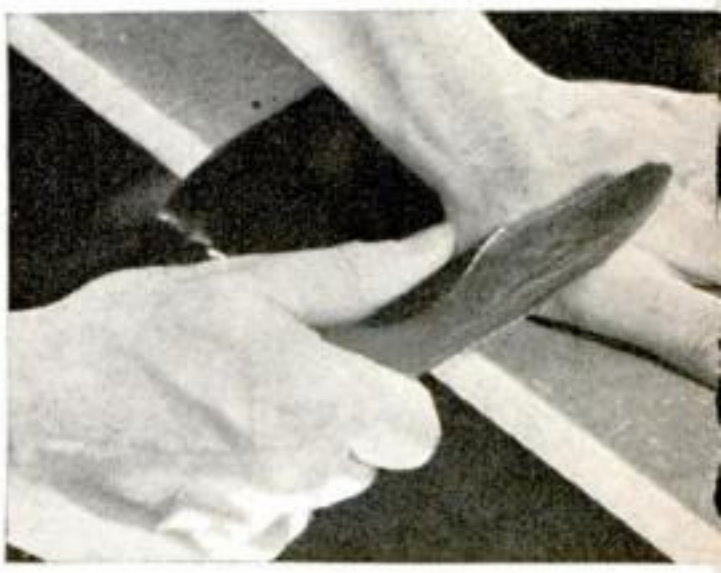
Having moistened the skin in a damp cloth for about 20 minutes, the cutter spreads it out on his table for examination, to check the foreman's estimate of the number of tranks to be got out of it, and to determine how they are to be cut. All cuts must be made so that

OVER

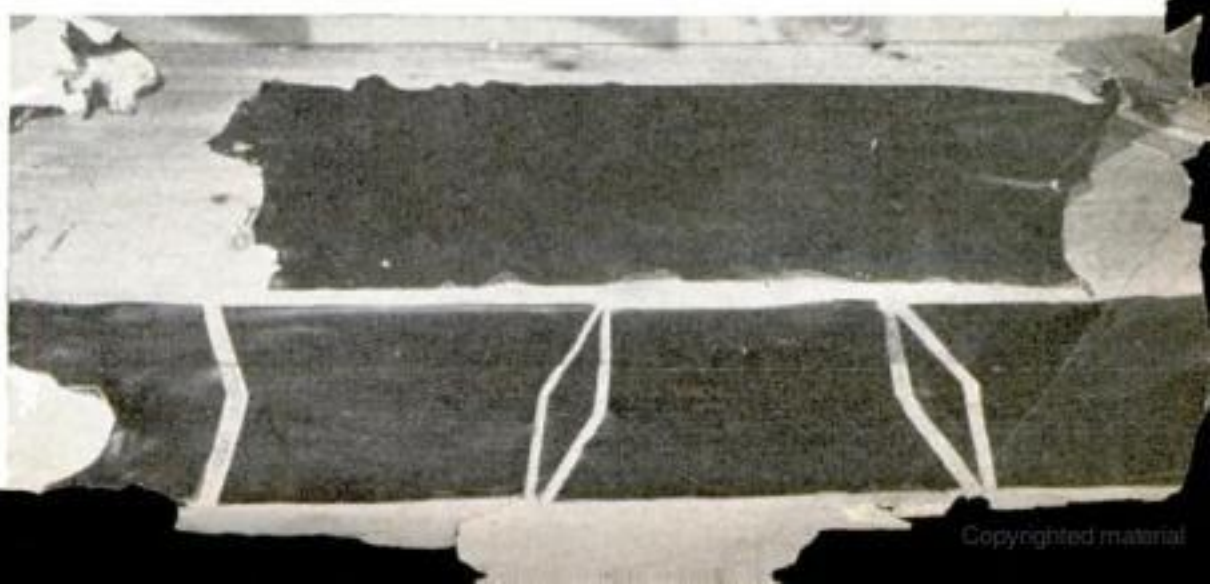
**CUTTING** When a moistened skin reaches the cutter's table, he first inspects it and decides how he will cut it into tranks for glove bodies. Different kinds of skins require different cutting, and imperfections must be made to fall where they will do no harm. Then he "pulls leather" into the trank and into the width, stretching the skin as many as five different ways to distribute the resilience and natural strains. A properly cut trank has almost no lengthwise stretch

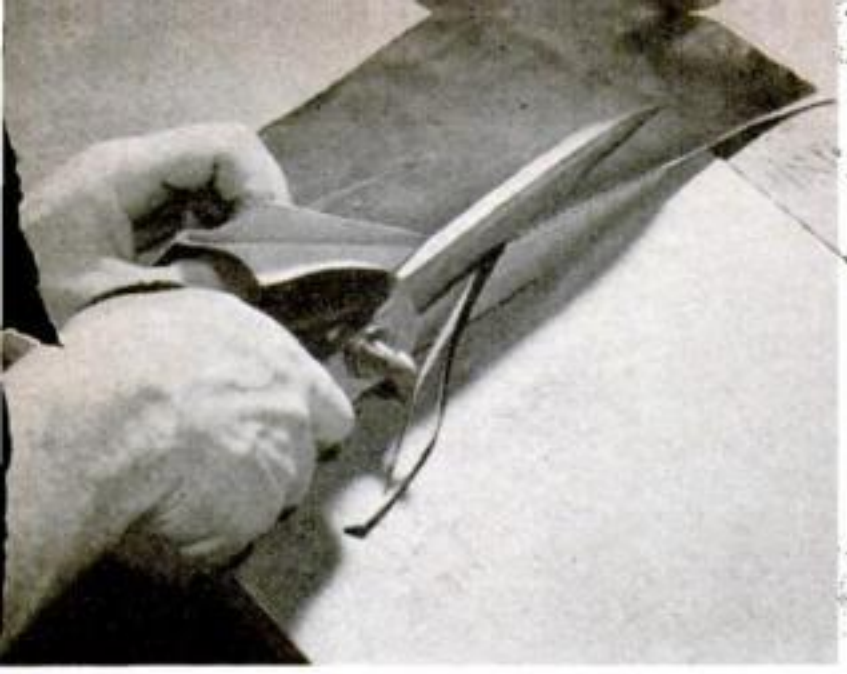


Every part of the trank must be pulled. The spud knife is used, as below, to stretch the edges which might not get their share of attention otherwise



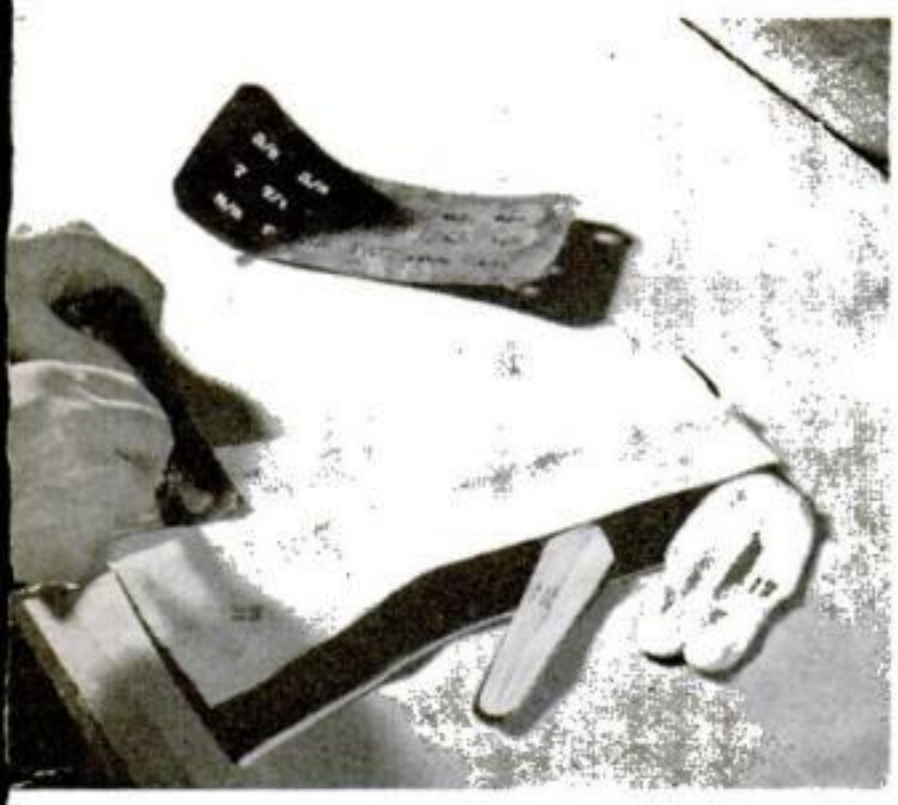
When the leather has been worked thoroughly, the cutter proceeds to cut it into tranks, usually six to a skin, or three pairs of gloves. Thumb and fourchettes are stamped from small pieces of leather with the dies and mallet shown on the opposite page. These "fittings" are marked to match a pair of tranks cut from the same skin. An expert cutter can cut about three dozen pairs of gloves in a full day's work





After cutting, the tranks are trimmed down to exact size. The cutter's job calls for a combination of strength and skill. There is no record of any woman having qualified as a cutter. She might conceivably acquire the necessary skill, but few women are strong enough to manipulate the leather

Here are the makings of a pair of gloves: the two tranks, two pieces of leather for the thumbs, and six pairs of pieces to make the fourchettes. The fittings that match a given pair of tranks must be rolled up together, secured with a rubber band, and sent to the fitting room where they are assembled



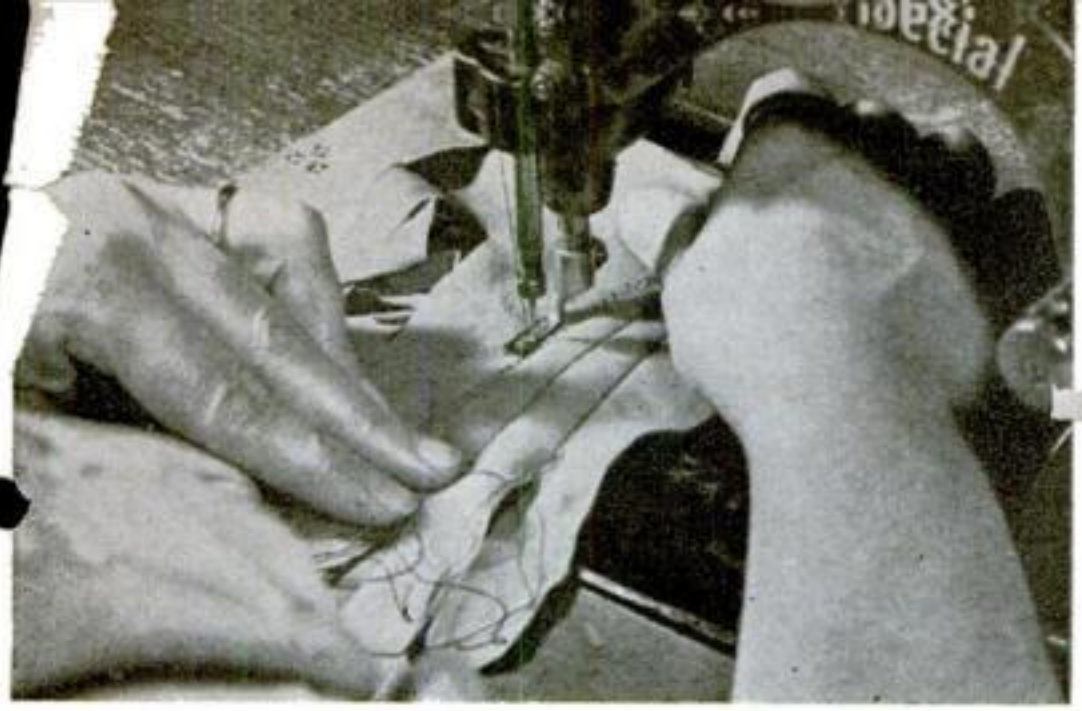
Each trank is marked for size and with directions for the guidance of the sewing room. It also is marked with a brass stamp stenciled with the letters "TC" arranged in a monogram design, and the cutter's number. Every pair of fine gloves bears these marks on the inside when it reaches the buyer

Tranks go from the cutter's table to the slitting machine, the only power machine used in glove cutting. From three to six tranks are placed on a die of the proper size and covered by several thicknesses of newspaper. The operator then presses a lever which forces the die through the leather, . . .

. . . cutting out the fingers and gouging the hole for the thumb. The two tranks for a pair of gloves go into the machine back to back, and the result is a trank cut for the right hand and for the left



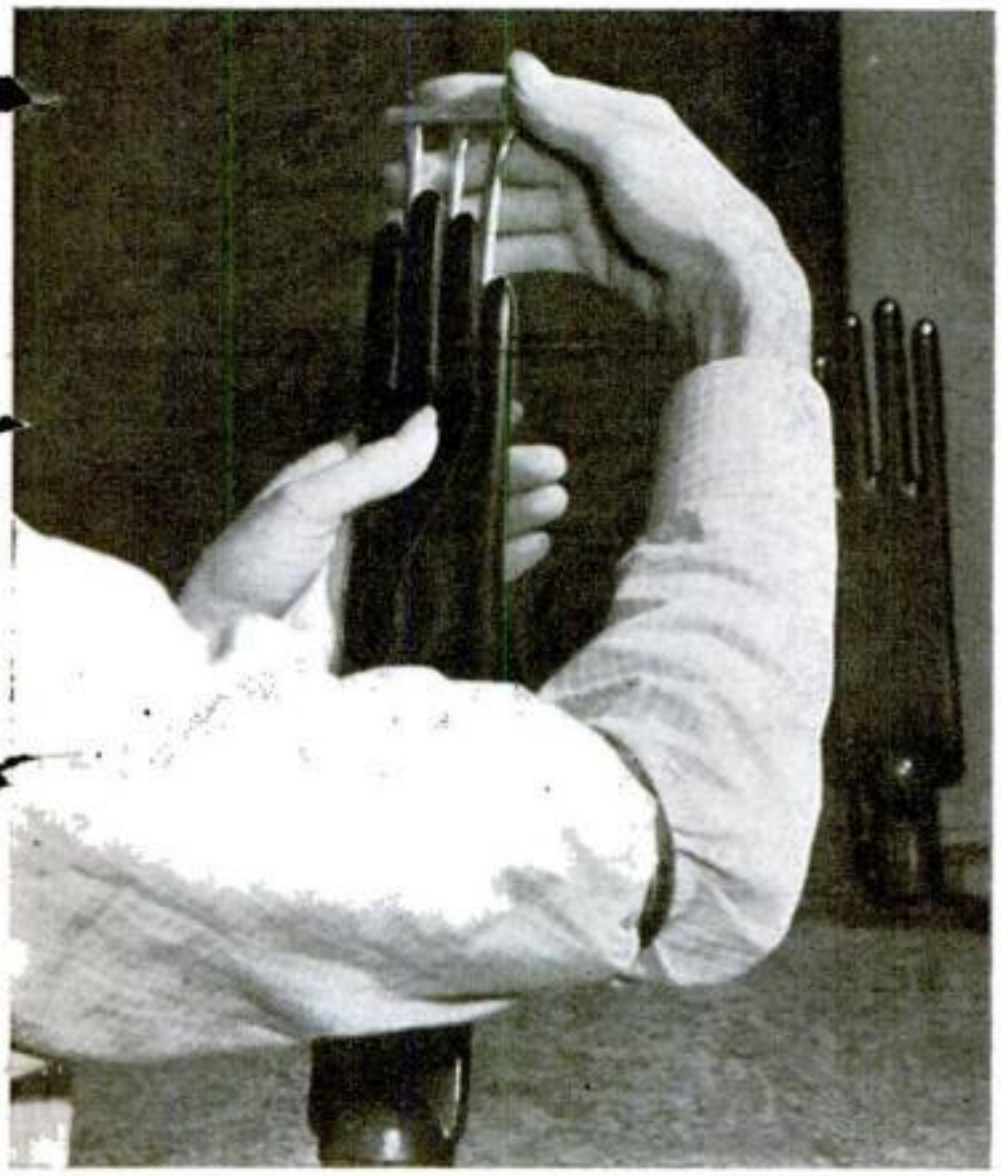
Here is a cut trank and the die that did the job. The small triangular pieces left hanging to the fingers are the "quirks," which will eventually be fitted between the fingers along with the fourchettes

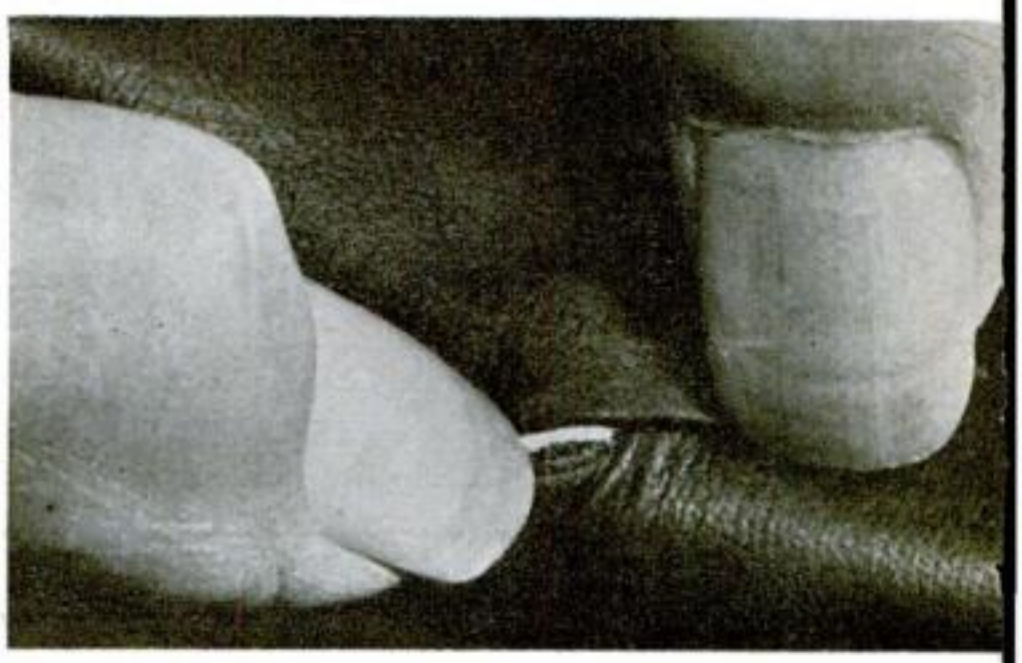


**SILKING** Machines put the three rows of stitching or embroidery on the back of each glove. The silker is guided by a punch mark left on the trank by the cutting machine. Silking may involve several operations

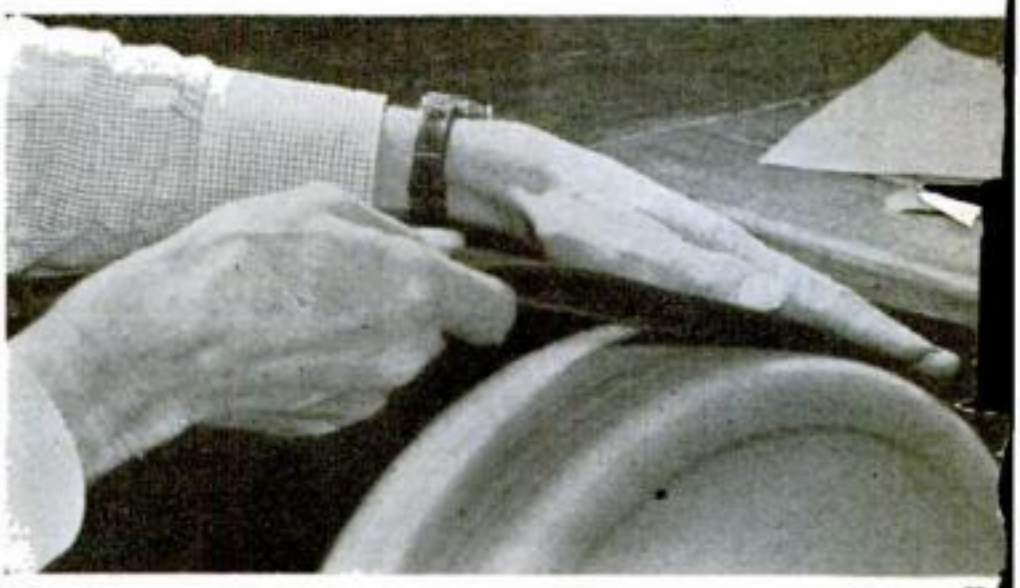
**MAKING** To the sewing room go the silked and slitted tranks, each pair matched with its proper fittings. Here women "makers" insert the thumbs, sew quirks and fourchettes in place, and close the finger pieces

**LAYING OFF** Dampened gloves are fitted on steam-heated forms shaped like hands, and the fingers are held in place by a three-pronged fork called a "tucker"





. . . while the operator tucks in the quirks and fourchettes with his thumb and forefinger nails. These nails must be guarded carefully. Polishing on a plush wheel, below, is the final operation



imperfections in the leather come on the seams, in the finger slits, on the embroidery lines, or in the area from which the thumb gouge is to be taken.

When all these matters have been determined, the cutter puts the skin through a process called "pulling leather into the trank." He first stretches the leather the long way, after which he measures the skin and slits it down the center. Then he stretches it in the opposite direction, or "pulls leather into the width." He continues to manipulate the skin—a good cutter can pull it five different ways—until the resilience and natural strains have been thoroughly distributed. Then he carefully cuts the tranks, usually six, or three pairs of gloves, from each capeskin, and spuds and smooths them to the desired size. Lengthwise there is virtually no stretch to a prop-

erly cut trank, as you can see by examining your fine gloves, but in width the cutter has made exact allowances, according to size, for movements of the hand.

The cutter now proceeds to cut the thumbs and the fourchettes, the small oblong pieces between the fingers. This he does by laying upon a piece of leather a steel die or pattern with very sharp edges and pounding it with a mallet. Cuffs and small segments of leather used as appliqué trimming are cut in the same manner. All of these, called "fittings," are marked to match a certain set of tranks cut from the same skin, and are then rolled together, secured with a rubber band, and sent to the fitting room. Five sizes of dies for the thumbs and three for the fourchettes are used for women's gloves in most factories, and the same number for men's gloves. These will cut fittings for glove sizes 5½ to 8, for women, and 7 to 10½ for men.

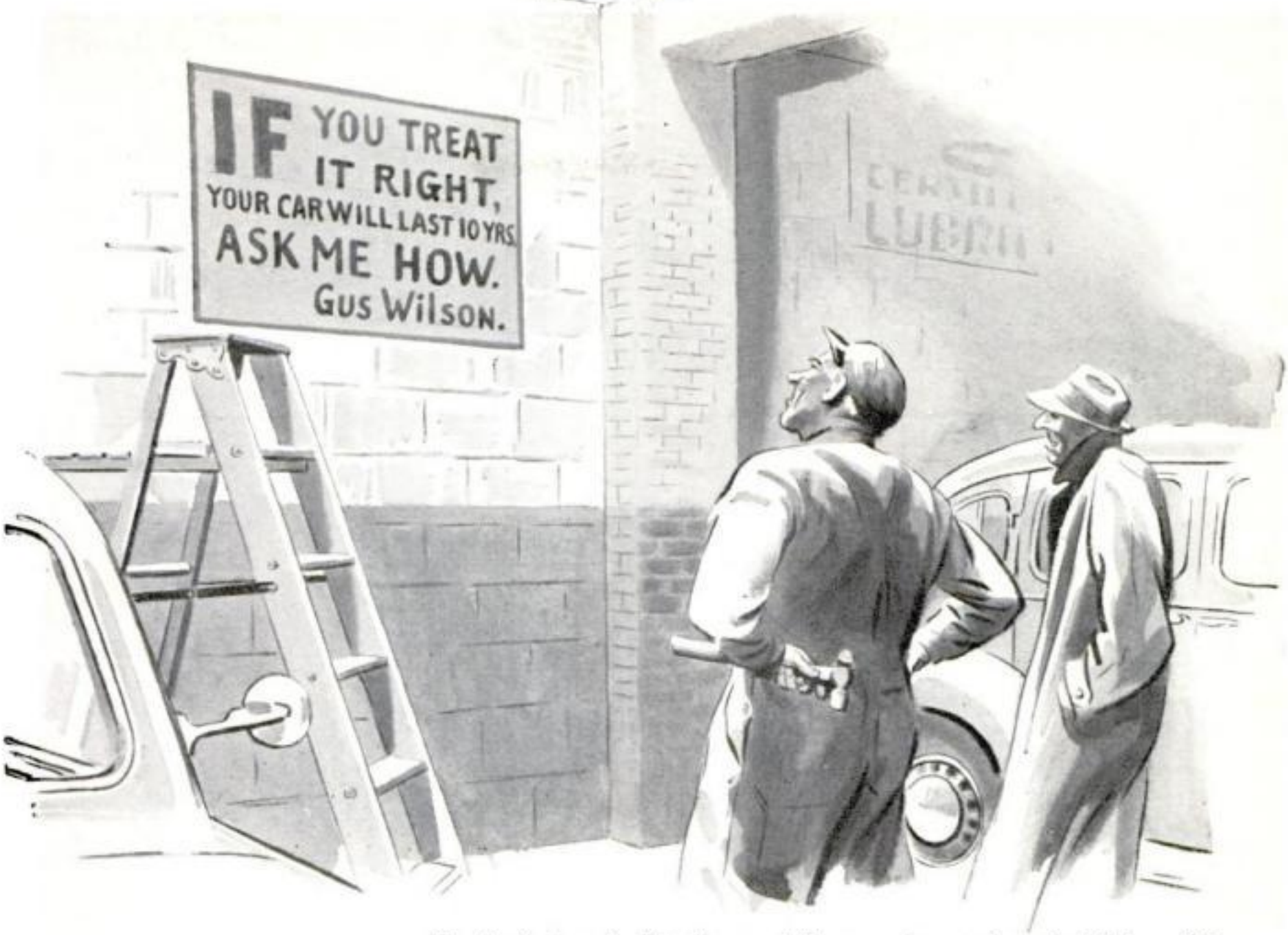
From the cutter's table the tranks go to the slitting machine, which is the only power machine used in glove cutting. A steel die of the proper glove size, shaped like a hand, is fitted into the machine, and upon it the operator places from three to six tranks, protected by several thicknesses of newspaper. He then presses a lever which forces the die up against a block and through the leather. This operation cuts out the fingers, gouges a hole for the thumb, and leaves dangling from the trank small triangular pieces, called "quirks," which are fitted between the fingers with the fourchettes. After slitting, the tranks are inspected and imperfect ones discarded, and are sent to the silking machines to receive the three rows of stitching or embroidery placed on the back of each glove. The silker is guided by a small punch mark placed upon the trank by the slitting machine, and before starting dusts the leather with French chalk to prevent binding and to permit feeding.

In the fitting room the silked and slitted trank is matched with the proper fittings, and the complete set of parts is sent to the sewing room, where it is put together by the "makers," all of whom are women. They insert the thumbs, sew the quirks and fourchettes in place, put on the cuffs, if any, and close the fingers. Many kinds of seams are used, depending upon the price of the glove and the purpose for which it has been manufactured. The glove must now be put through an operation called "laying off" before it is ready for the consumer. In the laying-off room, the gloves are first rolled in damp cloths until the moisture has penetrated, and are then fitted on steam-heated brass and copper forms shaped like hands, which bring them back to proper size and irons and smooths the leather. The thumb is laid off separately on a form called a "thumbing stick." The operator uses a brass three-pronged fork known as a "tucker" to hold the fingers in place, and tucks in the fourchettes and the quirks with the nails of his thumb and forefinger. These nails must be tough, hard, and from a quarter to a half inch long. Without them the layer-off cannot work efficiently, so he guards them carefully. If they are broken, the layer-off must usually lay off himself until they grow out again.

Laid-off gloves are stored for 12 hours to set the press, after which they are polished on a plush wheel to remove the chalk, fingerprints, and other evidences of handling. They are then inspected and sorted, broken threads are mended, buttonholes worked and buttons and clasps sewn on by hand, and the pairs tacked together and wrapped in tissue paper. They are now ready for shipment to the retailer.

So far, neither the tanners nor the manufacturers have experienced any great trouble on account of the war, though it is becoming increasingly difficult to get good skins. As mentioned before, none of the hides normally used in making fine gloves come from animals native to the United States. Capeskin, the most common material, is the skin of a South African haired sheep and is so called because the largest shipments are made from Cape Town. Other important glove leathers are made from hides brought from Spain, India, China, South and Central America, the Balkans, Arabia, Egypt, and the Sudan. Naturally, supplies of these hides are either cut off or greatly reduced, and existing stocks in this country are diminishing. Shortages of chrome and other chemicals used in tanning are expected to develop eventually, and many manufacturers believe that colors will be limited to black and two or three shades of brown because of shortages of chemicals used in dyeing.

Finger-Free gloves, a new development in design, have strips around fingers and down one side to give greater freedom.




He strolled up beside Gus and the new sign and snorted "Humpf!"

# "GUS makes them last"

By MARTIN BUNN

GUS WILSON backed down off the step-ladder and looked up at the sign he had just finished hanging on one of the walls of his Model Garage shop. Always a harsh judge of his own work, he admitted to himself that some of the lettering was a little crowded and that the net effect was not altogether professional. But in spite of any imperfections, he felt considerable satisfaction. For a fellow who made no pretense of being an artist it was a creditable sign-painting job, and maybe it would needle up some of the customers who read it. Just to get the idea of how it would sound to others, Gus read it aloud to himself: "If you treat it right, your car will last 10 years. Ask me how. Gus Wilson."

A little puffed up with pride of authorship, he continued to gaze at the sign as he loaded up his pipe. Absent-mindedly, he put it back in his pocket again, unlit, and was still gazing when a blast of cold air hit the back of his neck. Then, from behind him, there came a loud and disdainful *"Humpf!"*

Gus spun around and saw Vernon Hopkins standing just inside the wide-open doors. Vernon always looks grouchy, but now the expression on his thin face was practically poisonous.

"Shut that door!" Gus barked disgustedly. "Isn't it bad enough to get an April day in June without having some sap leave the doors open and let all of outdoors into the shop? What the dickens are you snorting about, anyhow?"

Vernon didn't make any move to close the sliding door. Instead, he strolled up beside Gus looking at the new sign and snorted another *"Humpf!"* Then he said: "Hooey!"

"What the devil do you mean—hooey?" Gus demanded indignantly. "What that sign says is the gospel truth. Any car built in the past ten years is good for ten years of satisfactory service if you treat it right."

"Yeah?" Vernon said. "I treat my car right, don't I?"

Gus had to admit that he does. He's one of the most careful owners on the Model Garage books.

"O.K.," Vernon said. "I'll show you why your sign is hooey."

He went out, and a half minute later drove his car into the shop. Gus closed the doors behind it. When he had finished that chore he found Vernon leaning out of his sedan's window. "Listen," Vernon said.

Gus listened. From somewhere under the hood there came a steady *thump—thump—thump*. Vernon speeded up the engine. The thumps still were there, but now they went *thump–thump–thump*–closer together.

"All right," Gus said. "There's a noise under your hood. What of it? How does that make my sign out to be a liar?"

Vernon cut his engine and got out of the car. "Do you know what that noise is?" he demanded.

"No," Gus said. "Do you?"

"Yes," Vernon told him. "It's a loose connecting rod. This car is two years old. It's had the best of care. There's less than 20,000 on its clock. But it has started to go to pieces. Where'll it be eight years from now, I ask you? That's why I say your sign is hooey."

"Loose connecting rod, hey?" Gus said reflectively. "Turn that engine over again, will you?"

Vernon got back into his car and restarted the engine. Gus listened intently for a long minute. Then he shook his head. "It doesn't sound like a loose connecting rod to me," he said. "What makes you think that's what it is?"

"I had this bus in the biggest repair shop down in the city about two hours ago," Vernon told him. "Their expert made a check and said it's a loose connecting rod."

"It still doesn't sound like a connecting rod to me," Gus said. "Well, whatever it is, when did it first go wrong?"

Vernon scratched his head. "I've been thinking about that and I don't think I really know; it must have come on very gradually, I suppose."

"Now that's going to help me a lot," Gus said with a touch of sarcasm. "When's the last time you had trouble of any kind with your car?" he added. "Think back, now."

Vernon thought it over for a minute, then ventured: "I guess it was early in April. I read where you should save your antifreeze on account of it will be hard to get next winter, so I drained it all out of my radiator and block and put it away in glass jugs. That very night we had a return engagement with Old Man Winter and when I went to start my car next morning there was a terrific squealing noise up front. It turned out that just the water pump was frozen up; nothing else. I thawed out the water pump and the noise stopped and everything was O.K. after that. That's the last trouble—if you can call it trouble—I had with the car, until this morning."

"And what happened this morning?" Gus put in.

"About ten o'clock I had to make a rush trip down to the city. As soon as I got out on the highway I noticed a noise and was suddenly aware that it had been there some time, not so loud, but I'm sure it was there. That same thumping noise you just heard. After I'd finished what I had to do in the city I thought I'd better get the bus checked, so I took it into that big garage. They said that a connecting rod was loose and about to let go, and wanted me to leave the car there to have a new one installed. But I didn't want to make another trip down to the city just to get my car after they had fixed it, so I took a chance and drove it home. It ran all right, and the noise wasn't much louder when I got here than it had been when I left the city. Well, what are you going to do about it?"

"The first thing I'm going to do," Gus told him, "is find out what really is the matter with your crate—which is more than those 'experts' of yours down in the city did. I've got my ears, and they've turned in all the evidence I need that there isn't anything wrong with your connecting rods." He raised the hood. "Now you get in there and start your engine, and keep it turning over slow—not much faster than idling speed—until I tell you to speed it up or to stop it."

Vernon got into the car and stepped on the starter. With the engine running slowly the thumping noise was noticeable. "Speed her up," Gus said. With the engine running faster the thumps were closer together and louder. "Slow her down," Gus said. "Just keep her turning over."

He stuck his head under the hood and put his keen ears and eyes to work. It didn't take him two seconds to locate the noise as coming from up front. Then his eyes caught

## GUS SAYS:

Pumping tires up to higher than the recommended pressure won't improve tire mileage. A couple extra pounds may not hurt them, but five or ten certainly will make them bounce on the roads and just wear out faster. The maker's recommendation is the best one to follow!

a movement where there shouldn't have been any movement. The generator was loose on its mounting, and at every turn of the fan belt it was jumping up and down.

Gus straightened up. "Switch her off. I've got it," he told Vernon. He examined the V-type fan belt closely. In one place, for about six inches, it was worn down considerably. Gus stood looking at the worn spot for the better part of a minute. Then he grinned. "Here's your grief," he said.

Vernon stared at the engine. "I don't see anything wrong," he said.

Gus pointed out the worn spot in the fan belt. Then he moved the generator with a finger. "Every time that worn-down place in the belt gets around to the generator," he explained, "it makes the generator jump on its mounting, causing a thump. Instead of a new connecting rod, all you need is a new fan belt and a tightening-up job on that generator."

Vernon grinned unwillingly. "That doesn't make me sore," he admitted. "Go ahead and fix her up. But there's one thing that I don't get yet. What made the belt wear down like that in that particular spot? The rest of it looks as good as new."

"It happened when the pump froze last April," Gus said. "When you started your engine that morning, your water pump was frozen up so tight that the fan belt couldn't turn it over. So what happened was that your engine turned the crankshaft pulley, but the belt couldn't operate because the pump wouldn't turn. The revolving pulley wore the stationary belt down at the place where they were in contact.

"As you said yourself, there'd been a little noise there—probably ever since. Finally, the vibration worked the generator mounting bolts loose. When the generator really began to bounce because of that worn spot and because it was loose—that just happened this morning—you really heard a loud noise. Get it?"

"Just my luck!" Vernon gloomed. "First time I ever heard of anyone having any serious trouble with a fan belt."

"So?" Gus said. "Well, lots of people have trouble with them, and sometimes it's serious trouble. What I'm trying to impress on all the people who bring their cars in here is that if they want to get the most out of them they should consider *any* trouble serious.

"Mrs. Miller came in one day last week scared half to death by a squealing noise she'd heard coming from somewhere under her hood—she thought her engine was shot all to blazes and she was in a dither because she wouldn't be able to get another car until after the Axis has been licked. There was a loud squeal, all right, but it was caused by a glazed fan belt doing a little slipping.

Gus straightened up. "Switch her off. I've got it," he told Vernon. "Here's your grief."

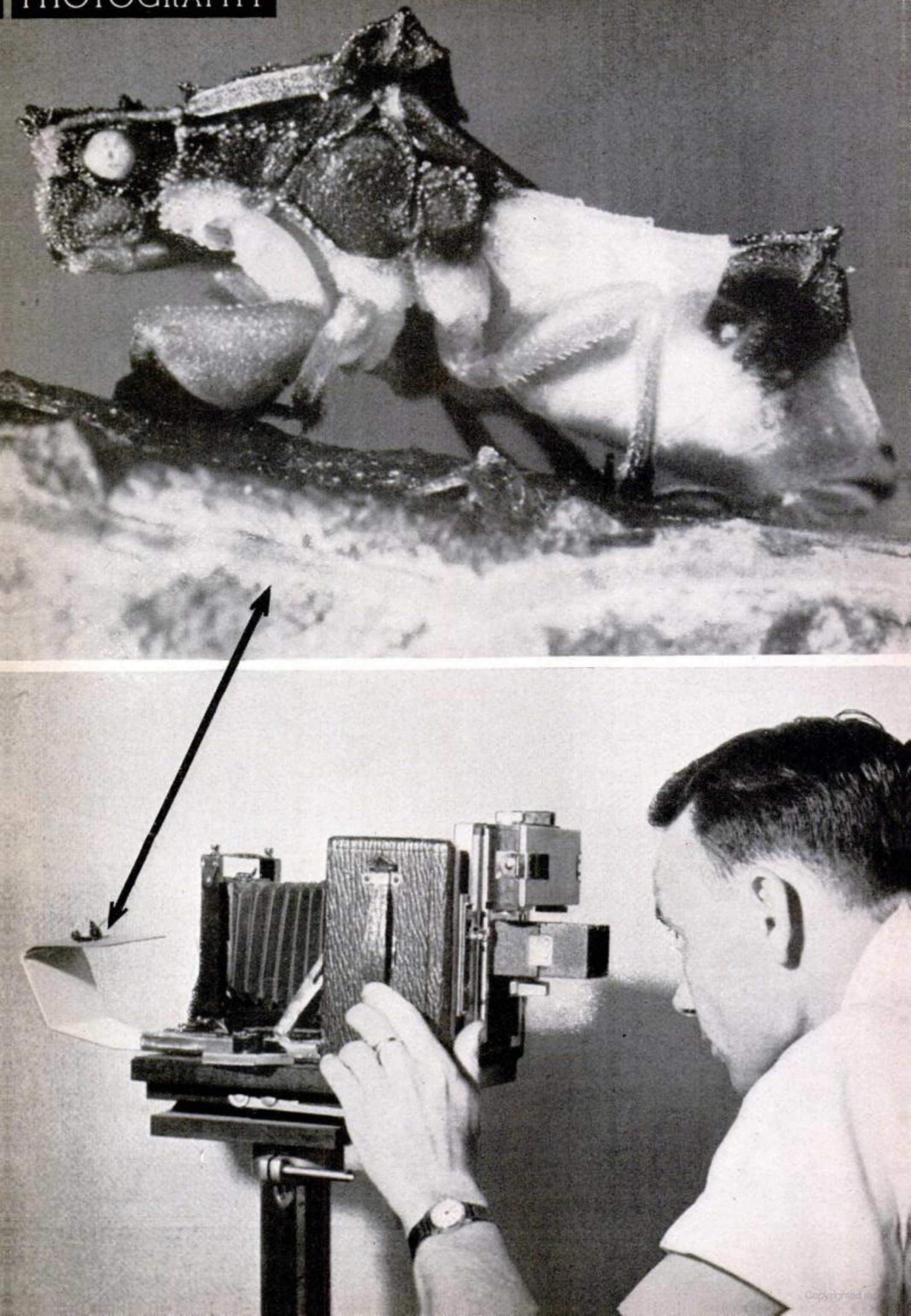
"That was only a little thing, but I was glad that she had brought her car in because we've got to take care of all the little things before they have a chance to grow into big ones. A slipping belt, or one that is too loose, doesn't rotate the fan fast enough to draw in sufficient cool air for efficient cooling; that causes the engine to overheat, and overheating isn't good for an engine. A belt that is too tight is as bad as one that isn't tight enough—it is likely to pull the water-pump impeller shaft out of alignment and cause excessive wear of the pump bearings, and eventually to make the pump leak."

"I suppose you're right," Vernon said grudgingly. "But how the dickens can you tell when your fan belt is about to go bad?"

"By using your eyes," Gus told him. "Take a look at your belt every month or so. Usually a fan belt is good for at least 15,000 miles, but now and then something makes one go bad suddenly—like yours did. A belt that shows the slightest indication of shredding should be replaced. A fan belt that breaks while you're driving can cause a lot of trouble. I know, because I've had it happen to me."

"Charge me up with a spare fan belt. I'll keep it in the car. Maybe there's some truth in that sign of yours, after all."

Gus grinned. "It's all truth!" he maintained. "There are eight years more of good driving in this bus of yours—*if* you treat it right!"



This portrait was made with the 35-mm. camera equipment described in the article below. It shows clean detail and excellent perspective

## AMATEUR PHOTOGRAPHER BUILDS

# Versatile 35-mm. Camera

COMPACTNESS, versatility, and economy are the principal characteristics of this little piece of homemade photographic equipment. Designed as a 35-mm. adapter for a copying camera, it is, in itself, an excellent miniature camera. The complete unit, including the focusing mount, removable lens board, ground-glass shield, magnifier, and portrait lens, is shown on the following page, while a view of the accessory in use as an attachment on a 4″ by 5″ plate camera is given on the facing page.

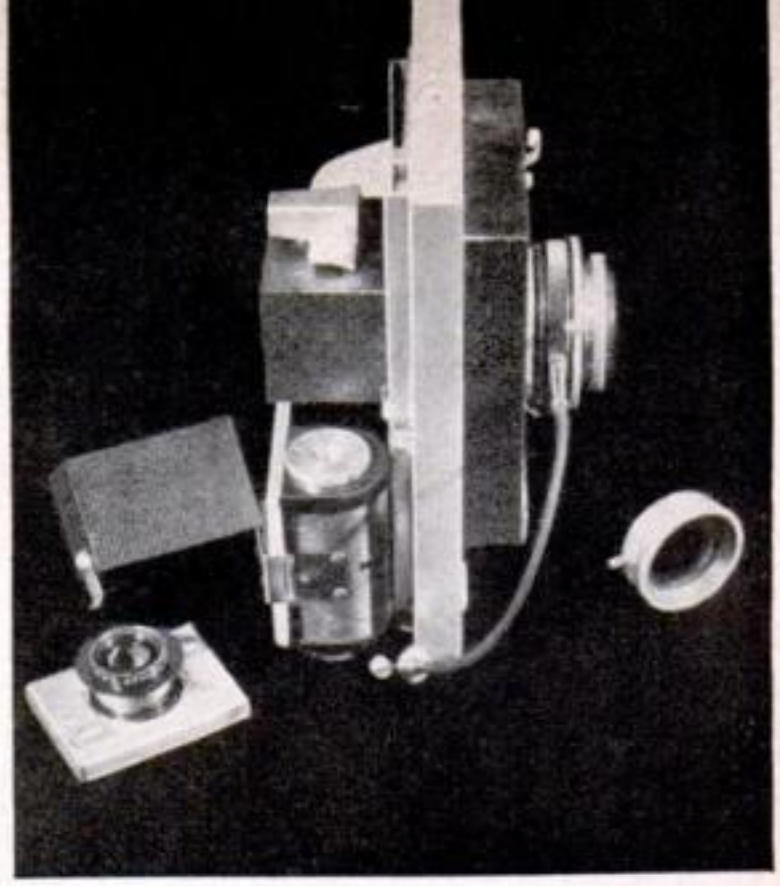
The film holder is a reasonably priced miniature camera without a lens, although if I were making this accessory over I should use a focal-plane camera so that it would be easier to change lenses. The small camera case and the ground glass are both rigidly mounted on a flat piece of 15/64″ thick metal with all edges rounded. This is held in place by ¼″ channel-brass strips, which serve as a track or slide.

The light trap is black felt. The optical view finder is mounted on top of the ground glass and comes into position only when the film carrier has been shifted into position behind the lens. The unit has two built-in tripod sockets for vertical and horizontal pictures.

With a 3″ lens the camera focuses from two feet to infinity. Focusing is done upon very fine ground glass by means of a helical mount with ⅝″ extension for rough adjustment, and by a front-element lens for fine adjustment. Both the mount and the lens are attached to a removable lens board. A rectangular hood shields the ground glass

At left, above, a highly magnified photograph of a ¼" insect taken with the aid of the homemade camera accessory. In this case, the lens board was removed from the unit and placed in position on the 4" by 5" plate camera shown below, and the adapter put on the back instead of a plate holder

Striking close-up of a flower. This was made in the same way as the portrait on the preceding page, and shows with great clearness the detail of veins in the petals and of light and shadow on the tiny drops of dew. The use of a 3" lens with 35-mm. film increases the fidelity of perspective



View of the 35-mm. unit from the side, showing the magnifier, portrait lens, and ground-glass shield. The "candid" view finder, mounted on the top of the ground-glass box, comes into position when the film carrier is raised for use

from glare, and a powerful magnifier assures critical focusing.

After the subject to be photographed has been carefully composed and sharply focused, the diaphragm and shutter are set for the predetermined exposure. The camera is then carefully slid into the position just occupied by the ground glass, and the picture taken.

The accompanying illustrations show what can be done with portraits and flowers. Notice the excellence of the perspective owing to the fact that a 3" lens was used on 35-mm. film instead of the usual 2".

For extremely small objects, greater extension is, of course, required. The lens board is therefore removed from this unit and placed in position on a 4" by 5" plate camera. The adapter is then placed on the back of the plate camera in the same way a plate holder would be.

An f/4.5 lens of 2" focal length was used for the high magnification needed to achieve the results shown in the photograph at the top of page 144. This insect, known as an "ambush bug," which is marked by the arrow in the picture at the bottom of the same page, was ¼" long. The exposure on Panatomic-X film was 10 seconds at f/16.

This front view of the versatile little camera gives a clear idea of how the focusing mount and removable lens board fit in place. The author notes that it took him many hours to make these pieces, but concludes that they were well worth the effort. Pictorial results back his opinion

With a 6" or 10" lens on the plate camera, striking telephoto shots also can be made. A good lens should be used, however, because the resolving power diminishes in proportion to the increase in the focal length of the lens.—RICHARD H. BILLS.

Jackson Rose is known on the movie lots as a "specialist's specialist" when it comes to process photography. He's a real veteran, too. Starting with the old Essanay Film Company at Chicago in 1910, he has worked behind the camera at all the big Hollywood studios and has been responsible as well for the invention of many pieces of equipment in wide use. For the last nine years his talents have reached the screen via M.-G.-M. His studies brought forth recently a thorough 250-page book, "American Cinematographer Hand Book and Reference Guide," which gives just about every chart and table needed for minicam and cine photography and from which were selected the accompanying tables

# Lens-Wise Is Picture-Perfect

**By JACKSON J. ROSE, A. S. C.**

QUICKLY, now, you amateur movie cameramen! How would you compensate for the light loss caused by using a 23A filter? What is the depth of focus of a 12½-mm. lens on an 8-mm. camera stopped at f/4.5? How much is a quarter-stop open from f/14? What is hyperfocal distance? How can you bring infinity nearer the lens?

A famous philosopher once said: "He who goes not forward, goes backward." This is especially applicable to those who, as professionals or amateurs, follow photography in its many forms. For photography is constantly advancing, and those who fail to march with it are left behind. New emulsions, new cameras, new projectors, lights and auxiliary equipment, and even new lenses are developed in rapid succession. With them come new uses for the camera, new effects to be had in the finished sequences, and new pleasures to be derived by the serious hobbyist.

On these pages are several suggestions and up-to-date tables to help the ambitious amateur keep in step. The tables speak for themselves, but first—about your lens:

This is a photographer's most precious belonging—and one that may be difficult to replace for some time. It is a precise optical instrument, but it will provide a lifetime of useful service if only common-sense precautions are observed in its handling.

Do not wipe a lens carelessly with any

available rag, handkerchief, or tissue. To remove dust, grit, sand, and the like, dust it gently with a fine camel's-hair brush. And never touch the glass with your fingers if you can possibly help it; always handle by the mount.

Should fingerprints or grease spots nevertheless appear on the surface of the lens, remove them with a swab of soft, well-washed linen lightly dipped in pure grain alcohol or ether, and be sure to wipe softly. Avoid touching the lacquered metal rims or mounts with the cloth, as either of the chemicals may mar the lacquer.

To polish, use a soft, clean, lintless cloth or specially prepared lens tissue, and there is no need to attempt to rub vigorously.

Do not leave a lens uncovered when you have finished shooting. Use a metal lens cap to ward off dust and other dangers. Protect the lens also from excessive heat, humidity, and dampness. A good carrying case for the camera and equipment will be found a great help.

Should it ever be necessary to unscrew any of the lens elements from the mount, be certain to replace them correctly. Thread them back carefully. Do not tighten them to an extreme degree, yet be sure they are secure enough not to become loose. Even a trifling maladjustment will throw a precision lens slightly out of focus and may spoil

**HYPERFOCAL-DISTANCE TABLE**

| Lens size → | 12½ mm. | 15 mm. | 20 mm. | 1 inch | 1½ inch |
|---|---|---|---|---|---|
| Lens value ↓ | HYPERFOCAL DISTANCE IN FEET | | | | |
| f/ 1.4 | 14½ | 20¾ | 36¾ | 59½ | 134 |
| 1.5 | 13½ | 19 | 34½ | 55½ | 125 |
| 1.8 | 11¼ | 16 | 28¾ | 46¼ | 104 |
| 2. | 10 | 14½ | 25¾ | 41¾ | 93 |
| 2.5 | 8 | 11¼ | 20¾ | 33½ | 75 |
| 3. | 6¾ | 9¾ | 17 | 27¾ | 62½ |
| 3.5 | 5¾ | 8 | 19 | 23¾ | 53½ |
| 4. | 5 | 7 | 16½ | 20¾ | 46¾ |
| 4.5 | 4½ | 6¼ | 14¾ | 18½ | 41¾ |
| 5. | 4 | 5½ | 13¼ | 16¾ | 37½ |
| 5.6 | 3½ | 5 | 9¼ | 14¾ | 33½ |
| 6.3 | 3¼ | 4½ | 8¼ | 13½ | 29¾ |
| 8. | 2½ | 3½ | 6½ | 10¾ | 23½ |
| 9.1 | 2 | 3¼ | 6¼ | 9¼ | 20½ |
| 11. | 1¾ | 2½ | 6 | 7½ | 17 |
| 12.5 | | 2¼ | 5 | 6¾ | 15 |
| 16. | | 1¾ | 4 | 5¼ | 11¾ |

## FILTER FACTORS

### COMPUTED INTO LENS STOPS

Showing amount of stops to open diaphragm for various filter-factor numbers

| Factor numbers | Stops open from normal | Factor numbers | Stops open from normal |
|---|---|---|---|
| 1 | 0 | 10 | 3¼ |
| 1.5 | ½ | 12 | 3½ |
| 2 | 1 | 14 | 3¾ |
| 2.5 | 1¼ | 16 | 4 |
| 3 | 1½ | 20 | 4¼ |
| 3.5 | 1¾ | 24 | 4½ |
| 4 | 2 | 28 | 4¾ |
| 4.5 | 2⅛ | 32 | 5 |
| 5 | 2¼ | 40 | 5¼ |
| 6 | 2½ | 48 | 5½ |
| 7 | 2¾ | 56 | 5¾ |
| 8 | 3 | 64 | 6 |

You know your filter factor, but how many stops must you open the diaphragm to compensate for the light loss? It's easy if you consult the above table. Let's suppose that your meter reading shows a light value of f/16. You wish to use a 23A filter, which has a factor of 4. This factor calls for two full stops open, so you open to f/8

## *Filters*

Of the 27 color filters available, the average amateur cinematographer will need for normal requirements only the four following:

**Aero 2** (yellow). Normal color correction for all types of panchromatic film; produces medium contrast; darkens blue sky a few shades; brings out clouds; greater haze penetration than Aero 1; popular filter for general exterior photography, particularly when more contrast is desired on cloudy days.

**23A** (red). Medium overcorrection for all types of panchromatic film; darkens blue sky and water for light night effects in sunlight; lightens normal panchromatic make-up; dark-

## *Hyperfocal Distance*

What is the hyperfocal distance of your lens—the distance at and beyond which all objects are in focus when sharp focus is secured at infinity? That's important to know, but are you aware that by focusing at only half the hyperfocal distance, everything from half the hyperfocal distance to infinity will be sharply defined? Here are the figures for both 8-mm. and 16-mm. cameras which have lenses of from 12½-mm. to 1½" focal length

*POPULAR SCIENCE*

ens greens slightly; lightens all yellow, orange, red, and magenta colors.

**56B** (green). Strong softening effect on all types of pan film; produces great green and yellow contrast; in combination with 23A is used for softer night effects without excessive contrast.

**3N5.** Combination of Aero 1 and 50 percent neutral density filter; light color correction without contrast; softens slight glare; generally used for open landscape, street scenes, desert, and snow scenes.

Stop openings and closings in quarter steps appear in the table at right. Reading down gives one full stop closed; up, one stop open; left to right, ¼ closed; right to left, ¼ open

The table below shows how to compensate for a filter. If your normal exposure is f/16 and your filter's factor is 4, the intersection of those two rows will give the proper stop, f/8

**LENS-STOP CALCULATOR**

OPENING OR CLOSING ¼, ½, ¾ AND 1 STOP FROM ANY SELECTED f-VALUE

| | | | |
|---|---|---|---|
| f/ 1.2 | f/ 1.3 | f/ 1.4 | f/ 1.5 |
| f/ 1.6 | f/ 1.8 | f/ 2 | f/ 2.1 |
| f/ 2.3 | f/ 2.5 | f/ 2.8 | f/ 3 |
| f/ 3.2 | f/ 3.6 | f/ 4 | f/ 4.2 |
| f/ 4.5 | f/ 5. | f/ 5.6 | f/ 6 |
| f/ 6.3 | f/ 7.2 | f/ 8 | f/ 8.5 |
| f/ 9.1 | f/10 | f/11 | f/12 |
| f/12.5 | f/14 | f/16 | f/17 |
| f/18 | f/20 | f/22 | f/24 |
| f/25 | f/28 | f/32 | f/34 |
| f/36 | f/40 | f/45 | f/50 |

**FILTER-FACTOR COMPENSATOR**

DIAPHRAGM EXPOSURE WITH FILTERS OF VARIOUS FACTORS

FACTOR NUMBERS

| Exposure without filter | 1.5 | 2 | 2.5 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| f/ 2.3 | f/2. | | | | | | | | | | | | | | | |
| 2.8 | 2.3 | 2. | | | | | | Exposure with filter | | | | | | | | |
| 3.2 | 2.8 | 2.3 | 2.2 | 2. | | | | | | | | | | | | |
| 4. | 3.2 | 2.8 | 2.5 | 2.3 | 2. | | | | | | | | | | | |
| 4.5 | 4. | 3.2 | 3. | 2.8 | 2.3 | 2.2 | 2. | | | | | | | | | |
| 5.6 | 4.5 | 4. | 3.6 | 3.2 | 2.8 | 2.5 | 2.3 | 2. | | | | | | | | |
| 6.3 | 5.6 | 4.5 | 4.3 | 4. | 3.2 | 3. | 2.8 | 2.3 | 2.2 | 2. | | | | | | |
| 8. | 6.3 | 5.6 | 4.5 | 4.5 | 4. | 3.6 | 3.2 | 2.8 | 2.5 | 2.3 | 2.2 | 2. | | | | |
| 9.1 | 8. | 6.3 | 5.9 | 5.6 | 4.5 | 4.3 | 4. | 3.2 | 3. | 2.8 | 2.5 | 2.3 | 2.2 | 2. | | |
| 11.3 | 9.1 | 8. | 7.2 | 6.3 | 5.6 | 5.1 | 4.5 | 4. | 3.6 | 3.2 | 3. | 2.8 | 2.5 | 2.3 | 2.2 | 2. |
| 12.5 | 11.3 | 9.1 | 8.5 | 8. | 6.3 | 5.9 | 5.6 | 4.5 | 4.3 | 4. | 3.5 | 3.2 | 3. | 2.8 | 2.5 | 2.3 |
| 16. | 12.5 | 11.3 | 10.1 | 9.1 | 8. | 7.2 | 6.3 | 5.6 | 5.1 | 4.5 | 4.3 | 4. | 3.6 | 3.2 | 3. | 2.8 |
| 18. | 16. | 12.5 | 11.8 | 11.3 | 9.1 | 8.5 | 8. | 6.3 | 5.9 | 5.6 | 5.1 | 4.5 | 4.3 | 4. | 3.5 | 3.2 |
| 22. | 18. | 16. | 14. | 12.5 | 11.3 | 10.1 | 9.1 | 8. | 7.2 | 6.3 | 5.9 | 5.6 | 5.1 | 4.5 | 4.3 | 4. |
| 25. | 22. | 18. | 17. | 16. | 12.5 | 11.8 | 11.3 | 9.1 | 8.5 | 8. | 7.2 | 6.3 | 5.9 | 5.6 | 5.1 | 4.5 |
| 32. | 25. | 22. | 20. | 18. | 16. | 14. | 12.5 | 11.3 | 10.1 | 9.1 | 8.5 | 8. | 7.2 | 6.3 | 5.9 | 5.6 |
| | CAMERA SPEED NORMAL – SHUTTER OPENING CONSTANT | | | | | | | | | | | | | | | |

what otherwise would have been one of your best pictures.

Lenses other than those intended for use with ground-glass, focusing-back cameras (this includes lenses for 8-mm. and 16-mm. movie cameras) are "set" at the factory so that they are in focus for their particular make of camera. By "set" is meant adjusted for the distance between the film and lens seat on the camera. Should you be unable to get sharp negatives even after the most careful focusing, you may be sure that this adjustment is out, and both lens and camera should be sent to the factory for readjustment. A lens should also be returned to the manufacturer for any other repair or adjustment that may be required. This course is a wise and easy safeguard against possible future regret.

Oddly enough, in making the optical glass from which present-day photographic lenses are ground, it is impossible to eliminate air

## DEPTH OF FOCUS: 12½-mm. LENS — 8-mm. CAMERAS

| Point of focus | f/1.5 | f/1.8 | f/2.5 | f/3.5 | f/4.5 |
|---|---|---|---|---|---|
| | IN FOCUS FROM | | | | |
| Feet | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. |
| 2 | 1 9 to 2 5 | 1 9 to 2 6 | 1 7 to 2 8 | 1 6 to 3 4 | 1 4 to 4 0 |
| 3 | 2 6 to 3 11 | 2 5 to 4 2 | 2 2 to 4 9 | 1 11 to 7 6 | 1 8 to 12 0 |
| 4 | 3 0 to 4 8 | 2 11 to 6 4 | 2 8 to 8 0 | 2 4 to 20 0 | 2 0 to Inf. |
| 5 | 3 7 to 8 2 | 3 4 to 9 2 | 3 1 to 13 4 | 2 6 to Inf. | 2 4 to Inf. |
| 6 | 4 0 to 11 3 | 3 11 to 13 2 | 3 6 to 24 0 | 2 8 to Inf. | 2 5 to Inf. |
| 7 | 4 7 to 15 2 | 4 4 to 19 3 | 3 9 to 56 0 | 2 11 to Inf. | 2 6 to Inf. |
| 8 | 5 0 to 20 10 | 4 7 to 29 4 | 4 0 to Inf. | 3 1 to Inf. | 2 8 to Inf. |
| 9 | 5 4 to 29 9 | 4 11 to 49 6 | 4 3 to Inf. | 3 3 to Inf. | 2 9 to Inf. |
| 10 | 5 7 to 43 4 | 5 3 to 110 0 | 4 5 to Inf. | 3 4 to Inf. | 2 10 to Inf. |
| 11 | 5 11 to 71 6 | 5 6 to Inf. | 4 8 to Inf. | 3 5 to Inf. | 2 11 to Inf. |
| 12 | 6 3 to 156 0 | 5 10 to Inf. | 4 10 to Inf. | 3 6 to Inf. | 3 0 to Inf. |
| 13 | 6 6 to Inf. | 6 0 to Inf. | 4 11 to Inf. | 3 7 to Inf. | 3 1 to Inf. |
| 14 | 6 10 to Inf. | 6 2 to Inf. | 5 1 to Inf. | 3 8 to Inf. | 3 2 to Inf. |
| 15 | 6 11 to Inf. | 6 4 to Inf. | 5 2 to Inf. | 3 9 to Inf. | 3 3 to Inf. |
| 18 | 7 6 to Inf. | 6 11 to Inf. | 5 6 to Inf. | 3 11 to Inf. | 3 4 to Inf. |
| 20 | 7 10 to Inf. | 7 1 to Inf. | 5 9 to Inf. | 4 0 to Inf. | 3 5 to Inf. |
| 25 | 8 9 to Inf. | 7 8 to Inf. | 6 0 to Inf. | 4 2 to Inf. | 3 6 to Inf. |

## DEPTH OF FOCUS: 1-inch LENS — 16-mm. CAMERAS

| Point of focus | f/1.5 | f/2 | f/2.8 | f/4 | f/5.6 | f/8 |
|---|---|---|---|---|---|---|
| | IN FOCUS FROM | | | | | |
| Feet | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. | Ft. In. Ft. In. |
| 3 | 2 10 to 3 3 | 2 9 to 3 3 | 2 8 to 3 4 | 2 7 to 3 6 | 2 6 to 3 11 | 2 3 to 4 3 |
| 4 | 3 8 to 4 4 | 3 8 to 4 6 | 3 6 to 4 6 | 3 4 to 5 0 | 3 0 to 6 0 | 2 11 to 6 7 |
| 5 | 4 7 to 5 6 | 4 6 to 5 7 | 4 4 to 6 0 | 4 0 to 6 8 | 3 7 to 7 10 | 3 3 to 10 0 |
| 6 | 5 5 to 6 8 | 5 3 to 7 0 | 5 0 to 7 6 | 4 6 to 8 6 | 4 2 to 10 6 | 3 8 to 15 0 |
| 7 | 6 1 to 8 0 | 6 0 to 8 2 | 5 8 to 9 0 | 5 3 to 10 10 | 4 3 to 14 0 | 4 1 to 23 3 |
| 8 | 7 0 to 9 4 | 6 10 to 10 0 | 6 4 to 10 11 | 5 10 to 13 4 | 5 1 to 18 8 | 4 5 to 40 0 |
| 9 | 7 9 to 10 9 | 7 4 to 11 6 | 7 0 to 13 0 | 6 2 to 16 3 | 5 6 to 25 2 | 4 8 to 90 0 |
| 10 | 8 6 to 12 3 | 8 0 to 13 3 | 7 6 to 15 0 | 6 6 to 20 0 | 5 10 to 35 0 | 5 0 to 100 0 |
| 11 | 9 2 to 13 9 | 8 10 to 15 0 | 8 0 to 17 4 | 6 8 to 22 3 | 6 3 to 51 4 | 5 2 to Inf. |
| 12 | 9 10 to 15 7 | 9 5 to 17 0 | 8 7 to 20 0 | 7 11 to 30 0 | 6 9 to 84 0 | 5 5 to Inf. |
| 13 | 10 6 to 17 0 | 9 10 to 19 0 | 9 0 to 23 0 | 8 0 to 37 1 | 6 11 to 182 0 | 5 7 to Inf. |
| 14 | 11 2 to 18 8 | 10 5 to 21 4 | 9 6 to 26 3 | 8 3 to 47 0 | 7 0 to Inf. | 5 9 to Inf. |
| 15 | 11 9 to 20 7 | 11 0 to 23 3 | 10 0 to 30 0 | 8 6 to 60 0 | 7 7 to Inf. | 6 0 to Inf. |
| 18 | 13 7 to 26 11 | 12 6 to 32 0 | 13 4 to 45 0 | 9 6 to 180 0 | 7 11 to Inf. | 6 5 to Inf |
| 20 | 14 8 to 31 5 | 13 6 to 39 0 | 12 0 to 60 0 | 10 0 to 400 0 | 8 3 to Inf. | 6 7 to Inf. |
| 25 | 17 4 to 45 8 | 15 6 to 64 0 | 13 7 to 150 0 | 11 1 to Inf. | 9 0 to Inf. | 7 0 to Inf. |
| 35 | 21 5 to 91 3 | 18 10 to 77 0 | 16 1 to Inf. | 12 10 to Inf. | 10 0 to Inf. | 7 8 to Inf. |
| 50 | 26 3 to 550 | 22 6 to Inf. | 18 8 to Inf. | 14 3 to Inf. | 11 0 to Inf. | 8 3 to Inf. |

## *Depth of Focus*

**Two persons are in your movie scene, one 6′ from the camera and the other 13′, and there is a church in the background 100′ away. Will all three be in focus? That depends—it depends both upon the point where you fix your focus and upon the size of your lens. The two tables given above show the depth of focus for the lenses with which most amateur movie cameras are equipped**

bubbles. Fortunately, their presence has so negligible an effect that they can be entirely discounted. They have no effect on the functioning or correction, and the loss of light transmission is infinitesimal.

Now, if you are convinced that a lens deserves good treatment, turn to the tables. In them you will find short cuts for removing many errors and making much easier the task of compensating for a new filter or opening a quarter-stop. These tables are accurate, too—the result of painstaking experiment and calculation.

## High-Grade, Flexible Black Paper Used for Enlarger Bellows

BUILDERS of homemade enlargers will find it profitable to visit the salesroom of a large paper supply house before deciding on the bellows material. Substantial, pliable paper stock suitable for the purpose is available in black and other dark colors. A sheet large enough for bellows for a 5″ by 7″ enlarger may be found at a negligible cost as compared with leather. Black photographic tape can be used over the seams.—J. M.

## Punch and Judy Theater Hides Camera from Children

GETTING young children to pose naturally indoors for a portrait is far from easy, as many amateur photographers have discovered. If much work of this type is to be done, it pays to follow the example of successful professionals and give the children something interesting to look at. In one studio devoted to child photography, the camera is set up behind a Punch and Judy theater. The children are fascinated by the puppets and pay little or no attention to anything else, so that it is a simple matter to take their pictures. —LAWRENCE GOTTLIEB.

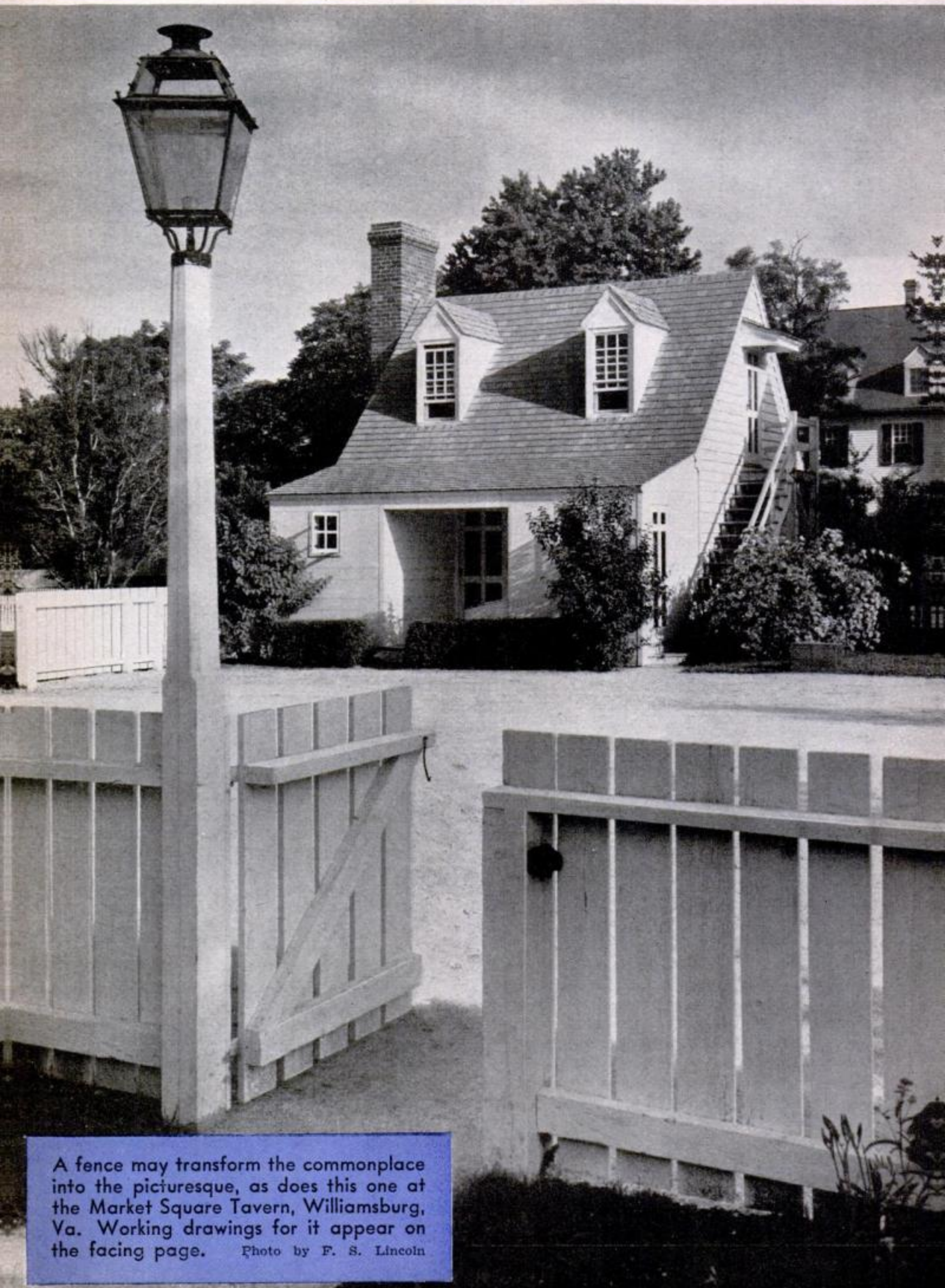
Children need not be urged to watch the puppets. Keen interest evokes a very natural pose

## Waxing Grooves of Tank Reel Is Aid in Loading Film

IF YOU find difficulty in pushing roll film into a spiral reel, put a little auto wax on a brush and rub it into the grooves. Very little is needed to leave a thin deposit and make film loading easy. It is even possible to develop two rolls of film at once by rolling the first all the way to the core and then following it with the second. This saves much time where a number of rolls are to be developed.—HAROLD EFFINGER.

## Cotter Pin Anchors Switch at "On" for Photoflash Use

IF THE same electric socket is used for both photoflash and photoflood lamps, a safeguard should be provided for locking the switch in the "on" position when a flash bulb is to be fired. Drill a hole in the black button for a small cotter pin that will keep the button from being pushed in. The pin can quickly be removed when the reflector is to be used for photofloods again afterwards.—KENNETH MURRAY.

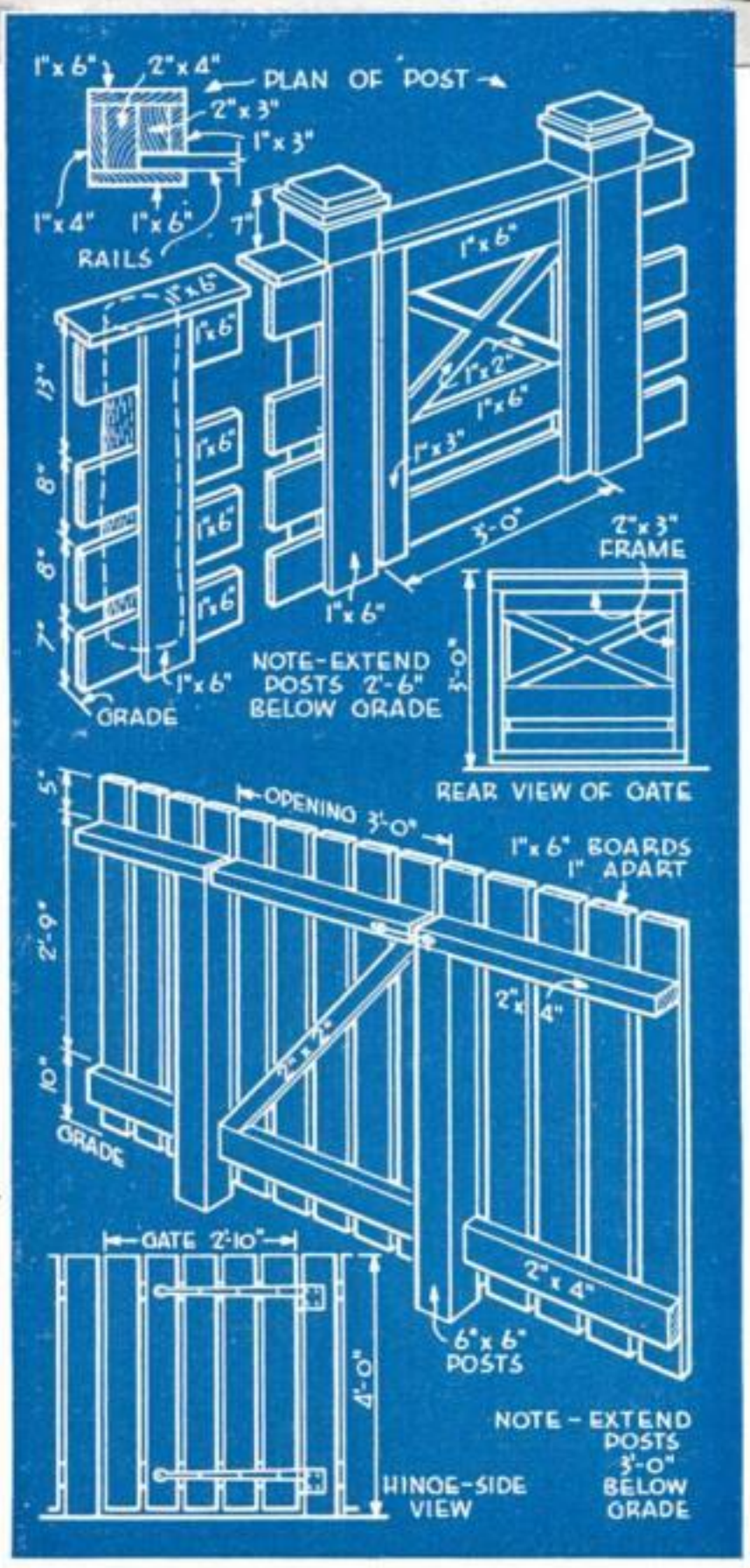


A fence may transform the commonplace into the picturesque, as does this one at the Market Square Tavern, Williamsburg, Va. Working drawings for it appear on the facing page. Photo by F. S. Lincoln


Fig. 1

# FENCES

## AUTHENTIC COLONIAL DESIGNS FROM OLD WILLIAMSBURG, ADAPTED FOR MODERN SMALL HOMES BY CARL T. SIGMAN AND WILLIAM J. WARD, JR.




ALMOST invariably one of the first acts of a settler in the pioneer days of this country was to build a fence around the land he had claimed for his own. As the American Colonies prospered and their architectural art reached heights unsurpassed even to this day, the variety and character of their fences kept pace with it. In Williamsburg, Va., where the atmosphere of the Old Dominion has been so marvelously retained and restored, one may see perhaps the greatest variety of picket, rail, and board fences to be found anywhere in this country. Though varied in style and design, they seem somehow to blend into one harmonious whole.

A simple, sturdy, easily built fence is the one inclosing the yard of the Market Square Tavern in Williamsburg. Working drawings for this appear at the bottom of the panel at the left. Note how the upper 2" by 4" rests

on the top of the posts while the lower one is toenailed to them. These lower rails may also be mortised into the posts if an especially strong structure is desired. Painted white, this makes a charming informal fence.

Another one that is simple to build and requires only a few sizes of lumber is shown at the top of the same panel and further illustrated in Fig. 1. All rails and the top board are made of 1″ by 6″ material. Stripped or unstripped logs set about 8′ on centers, or, if you prefer, 4 by 4's, may be used for the posts, with the exception of those at the gate. These are built up from 2 by 4's and 2 by 3's spiked together so as to permit the rails to be let in. For a more workmanlike job, pieces of 1″ by 3″ stock can be nailed in the gaps between rails in the posts after the other parts are in place.

Vertical 1 by 6's may be nailed on both sides at the posts instead of only on the outside, if you wish. Use 2 by 3's for the framework of the gate and nail a gate stop vertically against the latch post.

Many of us overlook the possibilities in painting fences something other than white. Pastel shades of yellow, green, or gray, the choice of which should depend upon the exterior color scheme of your home, may be interesting. A much-used gate, particularly if children are on the premises, may well be finished a darker color to make fingerprints less noticeable.

Often fences are not painted at all, but allowed to weather to a silvery gray and so become a less conspicuous part of the landscape. They will not disintegrate if left exposed to the elements, any more than do telegraph poles. When such poles must be replaced, it is usually because they have rotted below grade, not above. This suggests another important point to be considered in erecting a fence.

Fence posts, unless of a rot-resistant wood such as cypress, should be creosoted to a height of at least 2″ above ground. Only pressure-creosoted wood is permanently preserved, so be sure to buy this kind if you want a durable structure. Dipping in hot and cold creosote is only a temporary preservative because the penetration of creosote is only about 1/16″ to ¼″. In some localities pressure-creosoted timbers can be purchased in various sizes. Cypress, redwood, cedar, locust, and chestnut posts require no creosoting.

Some home owners creosote entire fences, giving them a warm brown color, which harmonizes nicely with English half-timber houses in particular. Never try to paint over creosote, because it will invariably bleed through the paint.

You can use fences in other ways than merely to surround your proper-

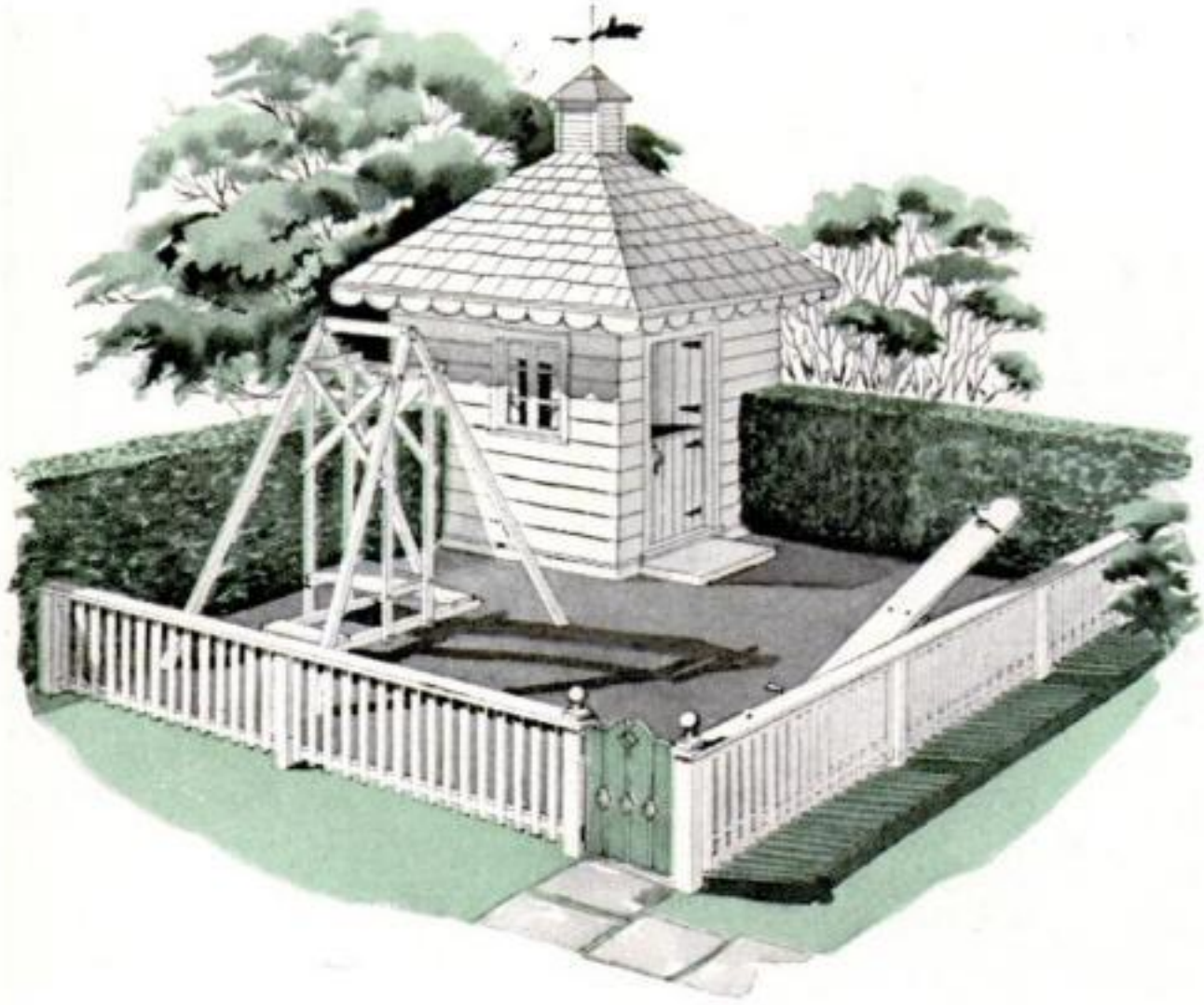



Fig. 2. What children wouldn't enjoy a play yard of their own? The fence has no sharp points, and it is low enough for them to sit on safely

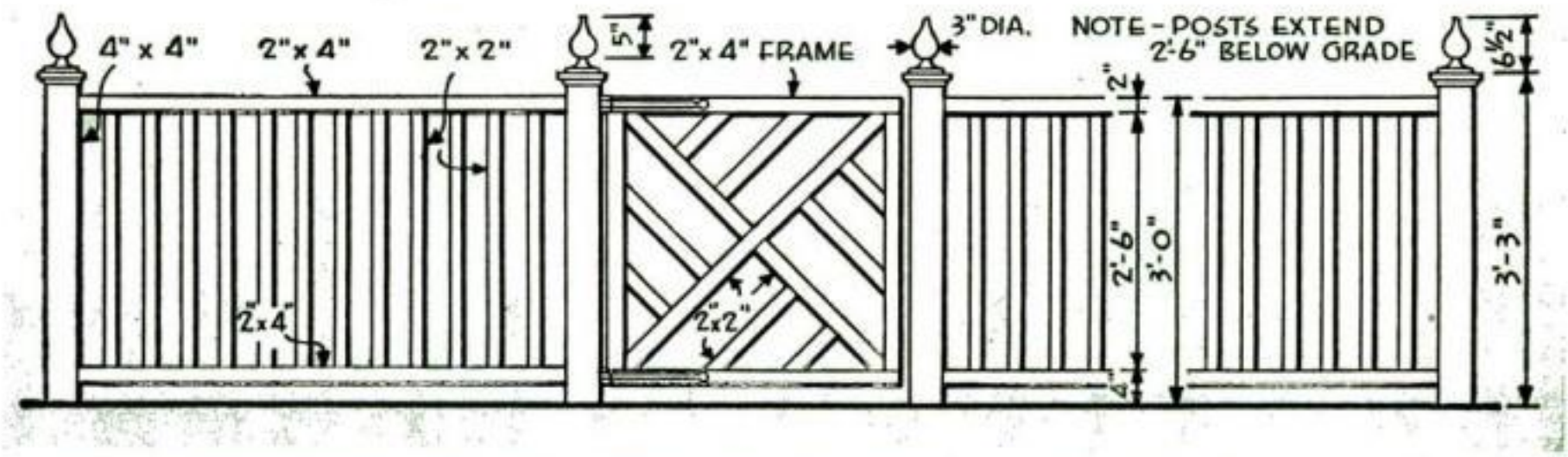


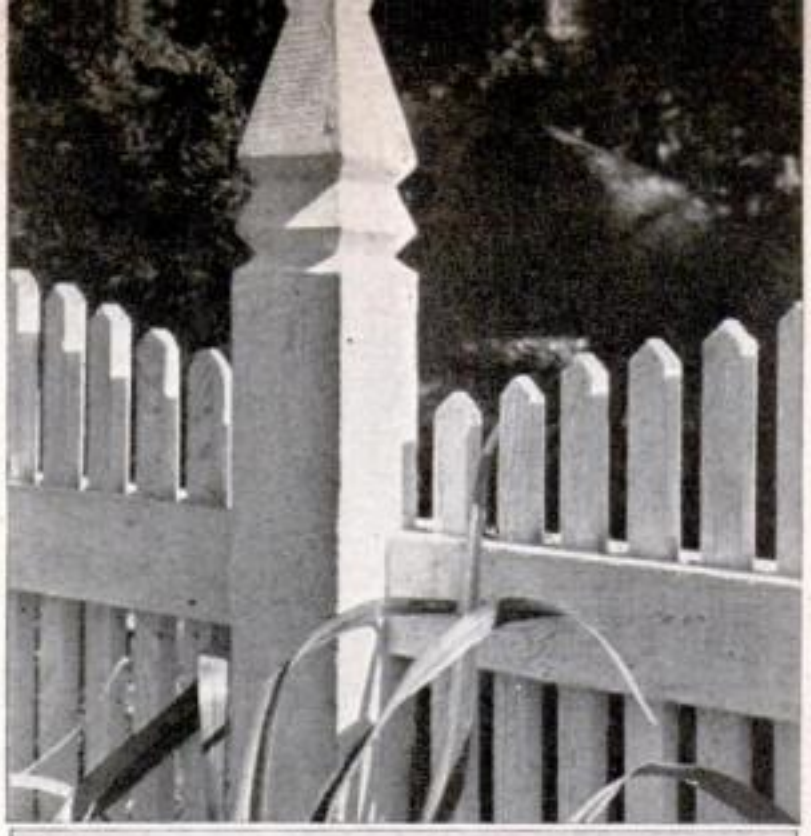

Fig. 3. This picturesque fence adds charm to an open terrace. It requires only three sizes of lumber

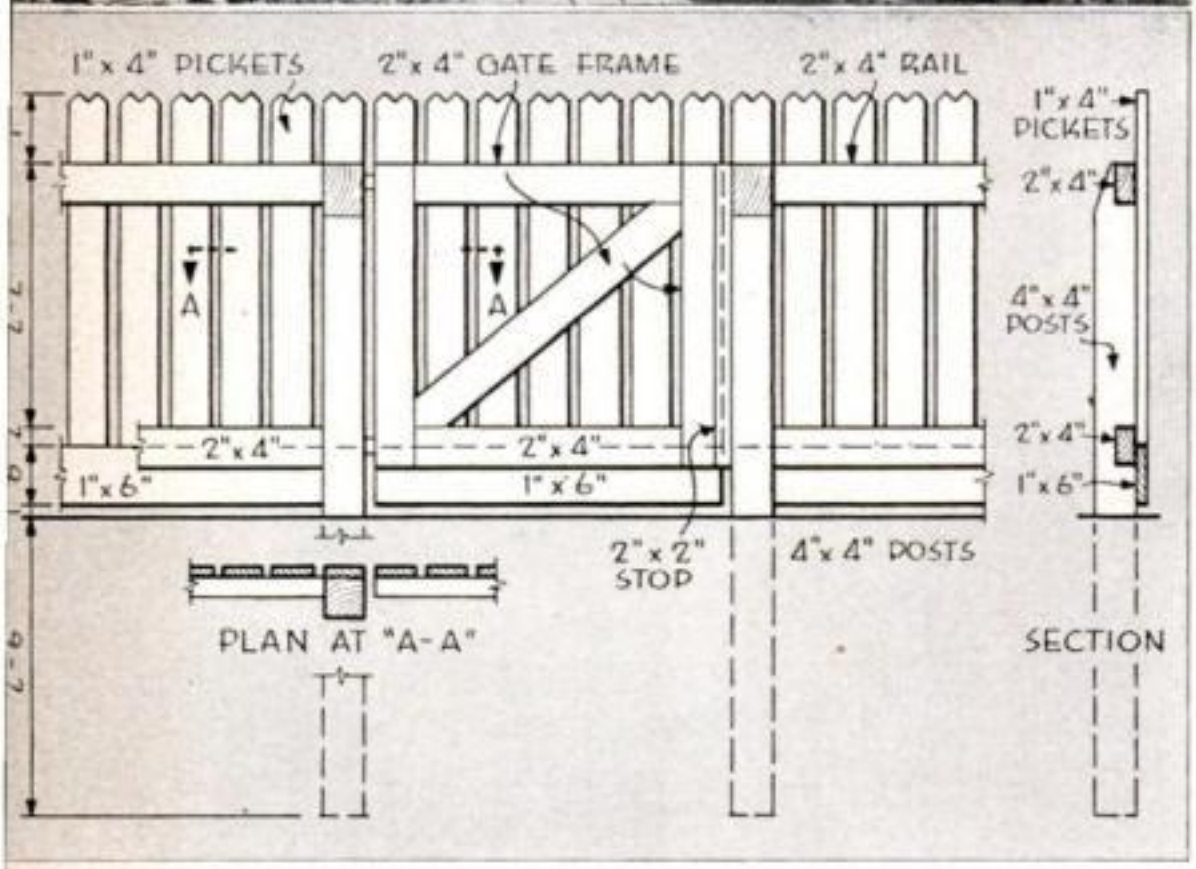
ty. In Fig. 2, for example, is shown a fenced children's play yard—one answer to the problem of keeping busy little feet off a struggling lawn. Children may be injured on picket fences, so this one is designed with a flat top and is low enough for a child to sit on. The top board is 1″ by 6″ stock, from which you may have left enough short ends to make the gate. The verticals are 1 by 2's nailed 2″ apart, and the rails are 2 by 3's let into the posts for greater strength. A "scab" or board of durable wood nailed to the gate posts below ground permits the use of shorter posts. In the same way short pieces of 1″ by 6″ or 1″ by 8″ material nailed to the sides of the other posts a few inches from the bottom ends make for greater strength and durability.

An open terrace can be charmingly "dressed up" with a fence, as suggested in Fig. 3. The inclosure is made of 2 by 2's nailed between 2″ by 4″ rails, and, of course, centered on them. No additional sizes of lumber are required for the gate. The posts are 4 by 4's. Well-placed shrubs enhance the effect of the fence. Some of the other designs shown can be adapted to form terrace inclosures.

Two of the oldest and most interesting fences in Williamsburg are shown in Fig. 4, together with working drawings. Here it may be noted that redwood, cedar, or cypress pickets may be purchased in packages of various lengths, sizes, and shapes. Such ready-cut stock greatly simplifies the construction of fences like these. Your lumber dealer may have or may be able to get shaped pickets for you.

By building a fence and trellis such as shown in Fig. 5 between your house and detached garage you gain unity in the architectural effect and privacy on what is usual-





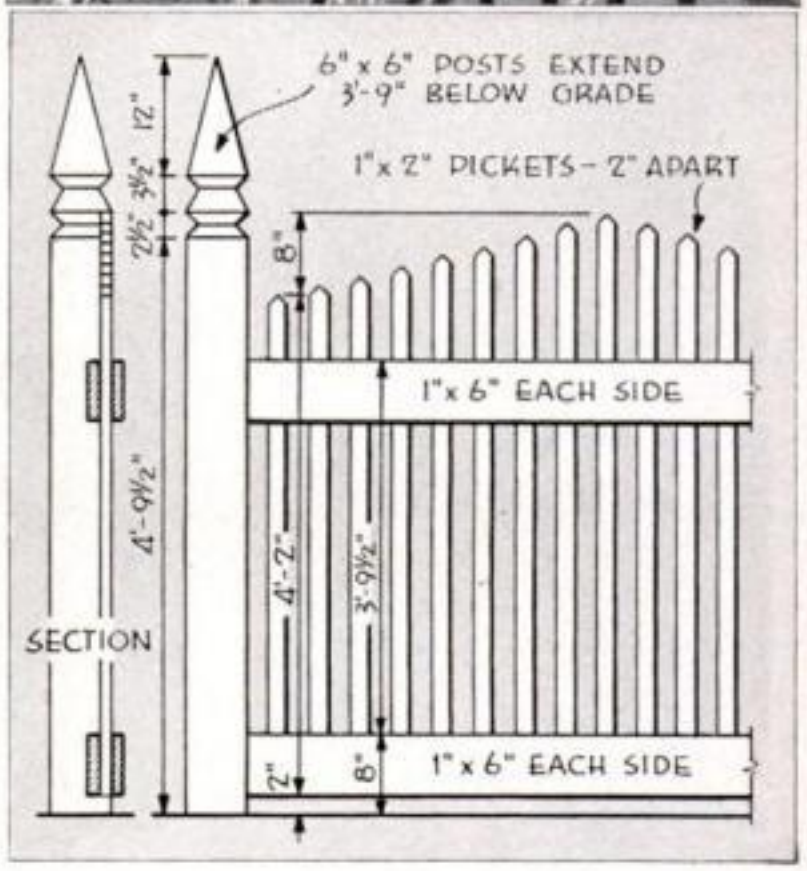
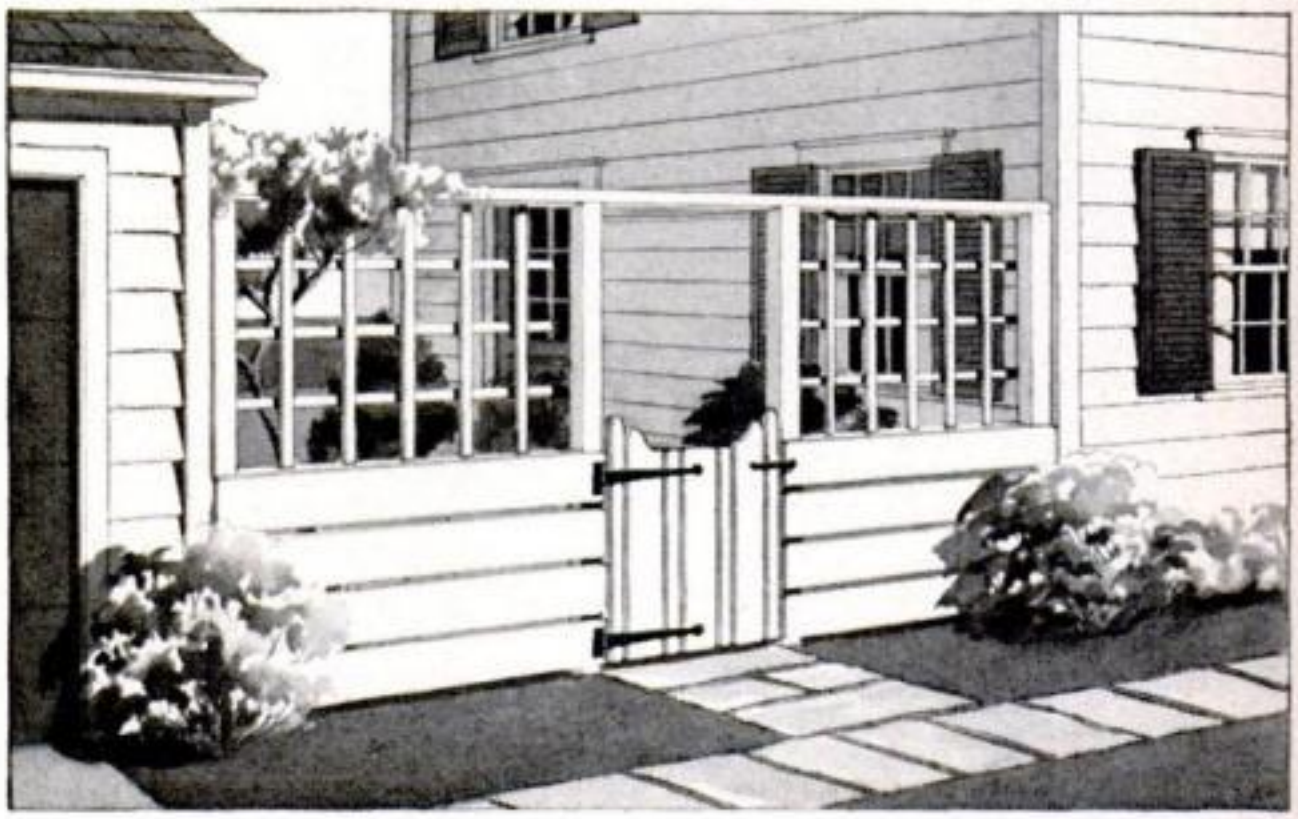




Fig. 4. Two authentic Colonial fences photographed in the reconstructed village of Williamsburg, Va. The drawings show how these can be reproduced on any property. Shaped pickets will help speed the job

ly the less sightly kitchen side of the house. Such a fence may help to hide garbage cans and the milk box and also provides a play terrace for small children away from the dangers of autos and other street traffic.

Well designed though the old Colonial gates were, their chief color and charm lay in the hand-wrought hinges and latches with which they were fitted. Some good reproductions of Colonial hardware are made today, but if you have a forge and some scraps of strap iron, you may prefer to hammer out your own. Perhaps in your neighborhood there is still a blacksmith who can be prevailed upon to make the pieces you require. Figure 6 shows a number of authentic Colonial designs. The patterns may be made larger or smaller as necessary by drawing them on squares of appropriate size.

To prevent rust stains from nails or, worse still, the complete disintegration of joints, use hot-dipped galvanized iron 8d. or



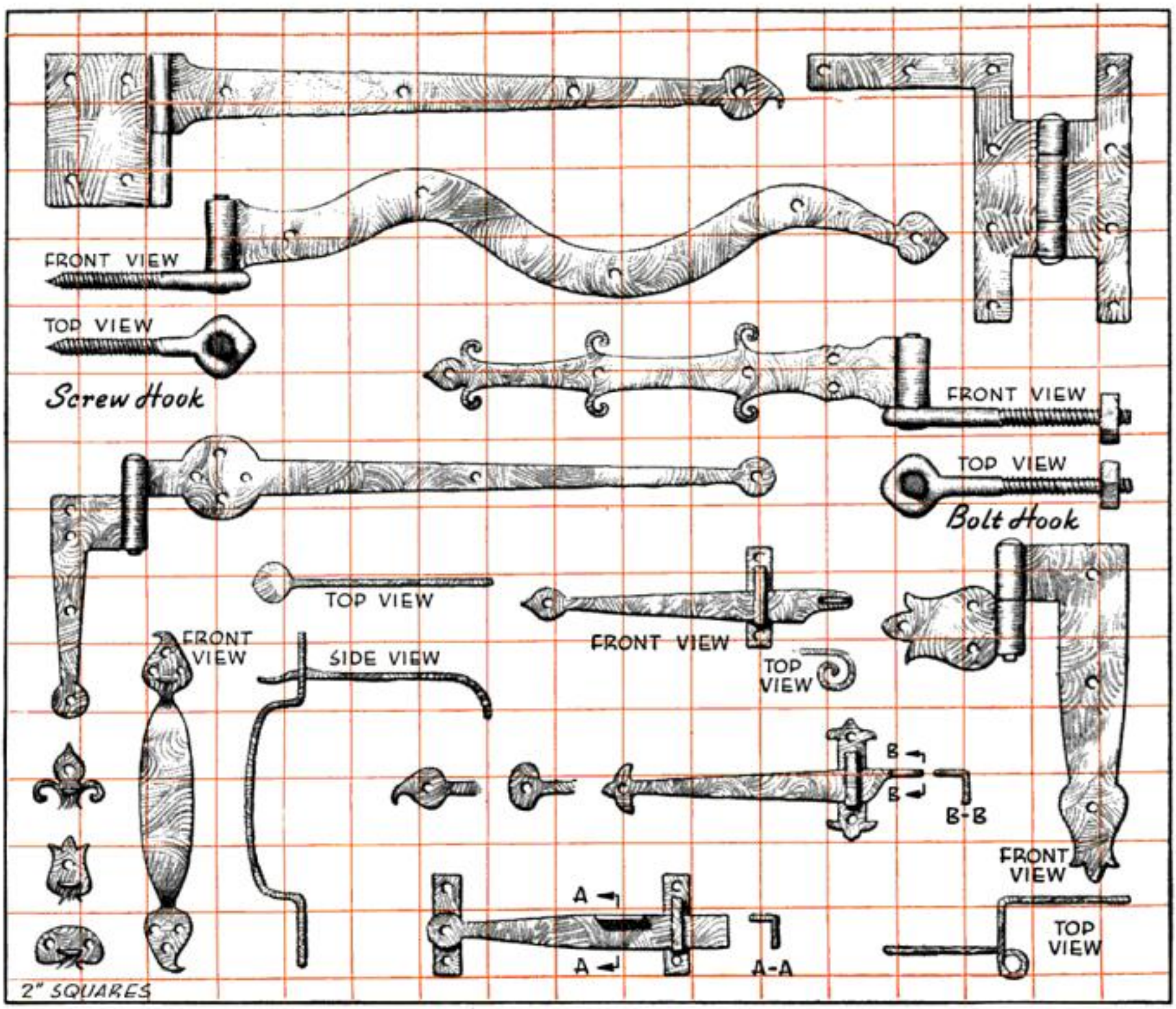



Fig. 6. If appropriate fence hardware is not available, why not make your own or have it made to order from these patterns? They can be scaled by means of the squares to any size most suitable

10d. nails. Should these prove hard to obtain, use tinned fence nails and keep them painted.

If there is one section of every yard that should be separated from the remainder and hidden from the public gaze, it is the area in which laundry is hung to dry and garbage and ash cans are stored. The back-yard fence in Fig. 7 is built of random-width boards, of which you may have enough on hand or which may perhaps be bought cheaply in short lengths at your lumber yard. The 4" by 4" posts also serve as poles for the wash lines. Sections of old broomstick driven through holes in the posts make excellent pegs to which to tie the clothesline.

Home gardens have become increasingly popular since the war emergency,

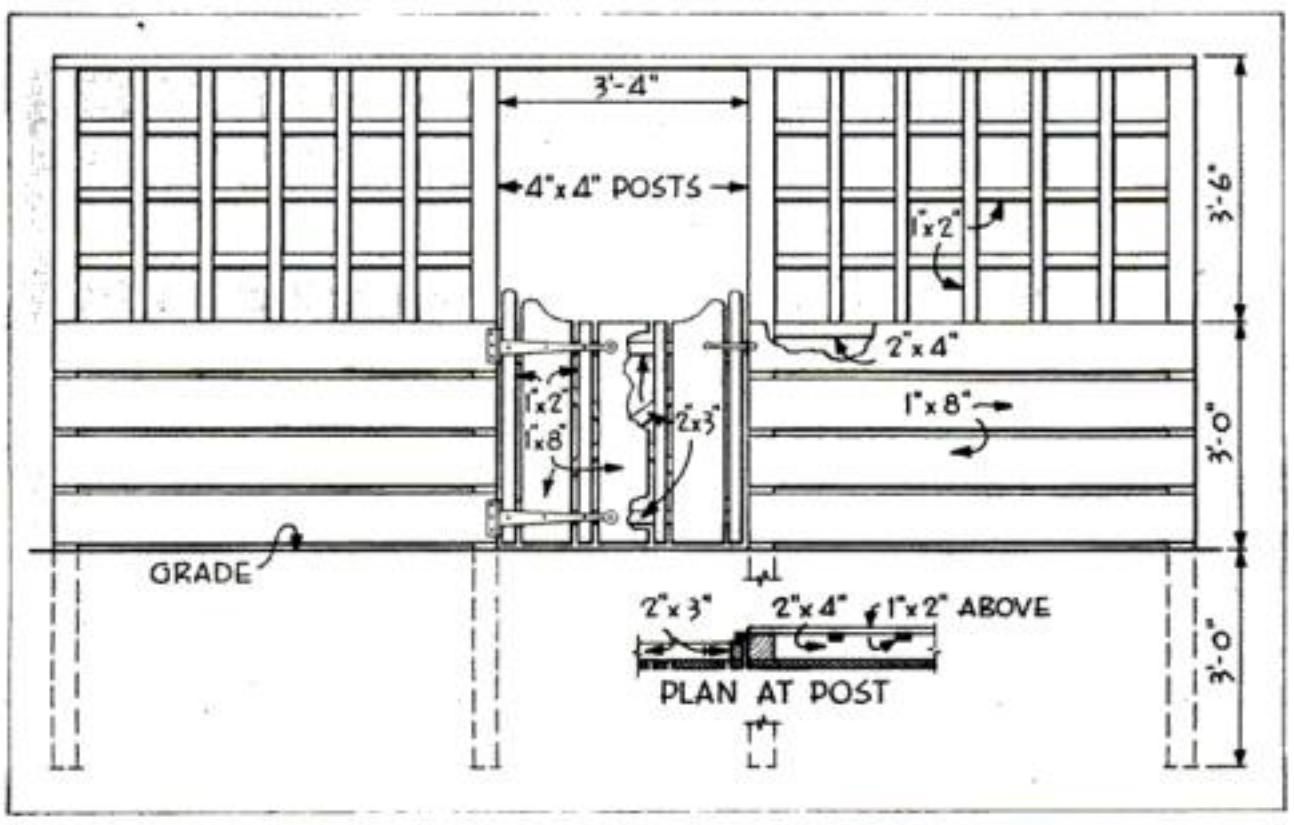



Fig. 5. A gap between the house and garage can be transformed into an architectural asset by closing it in with a fence and a trellis, as shown at the left

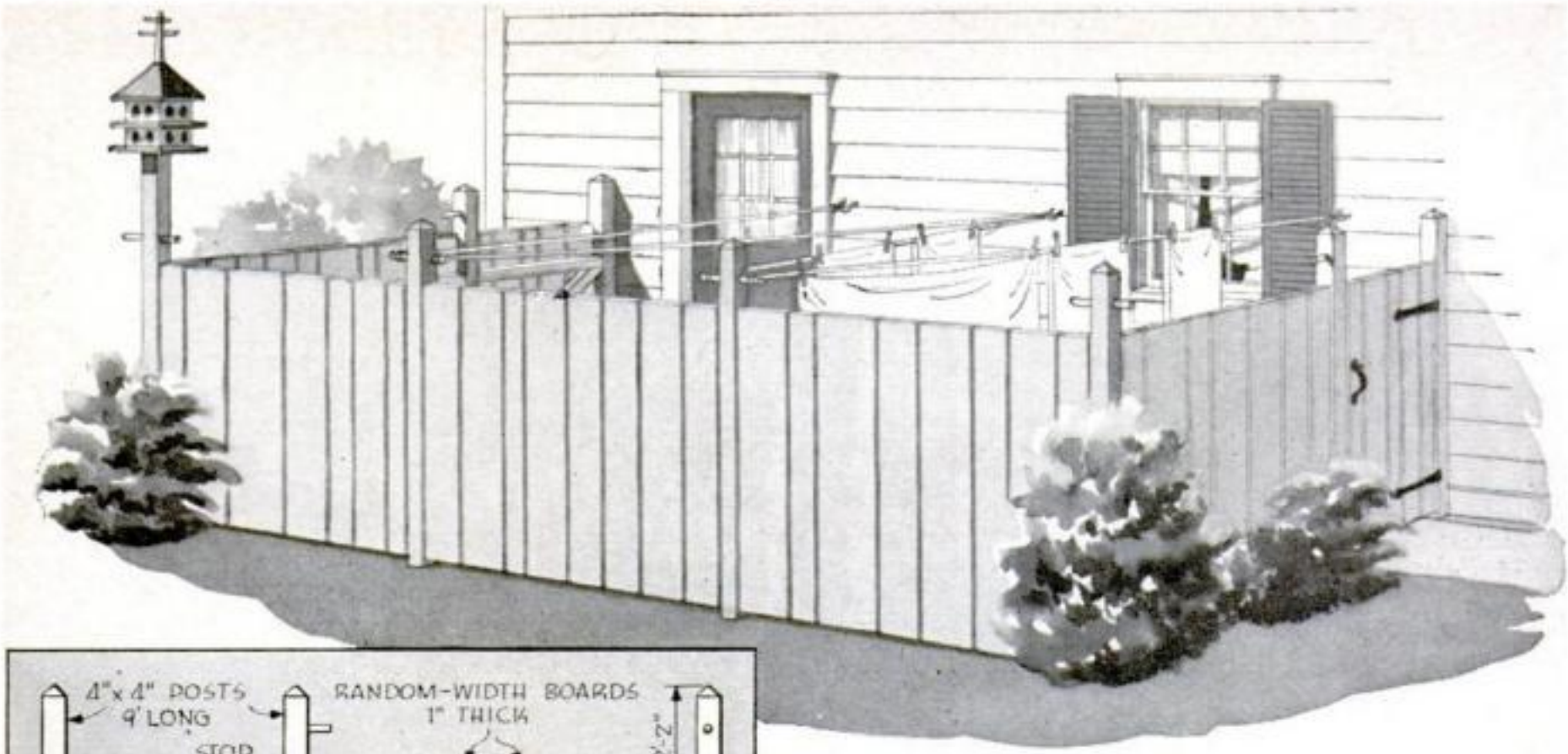



Fig. 7. Wet clothes need not be carried so far if there is a fenced-in laundry yard beside the house

and can be started almost anywhere. However, growing vegetables all but demand a fence about them to keep out dogs, rabbits, chickens, and romping children. For the garden inclosure shown in Fig. 8, two lengths of 1″ by 3″ pickets are used alternately, forming above the middle rail a more open structure upon which grapevines, pole beans, or other climbers can be trained to grow.

Two coats of white lead form a durable finish. A good formula consists of 2 gal. turpentine, 4 gal. linseed oil, and 1 pt. drier to 100 lbs. white lead. Let this priming coat dry one or two weeks. Use 2½ gal. oil, 1 qt. turpentine, and 1 pt. drier to 100 lbs. white lead for the finishing coat.

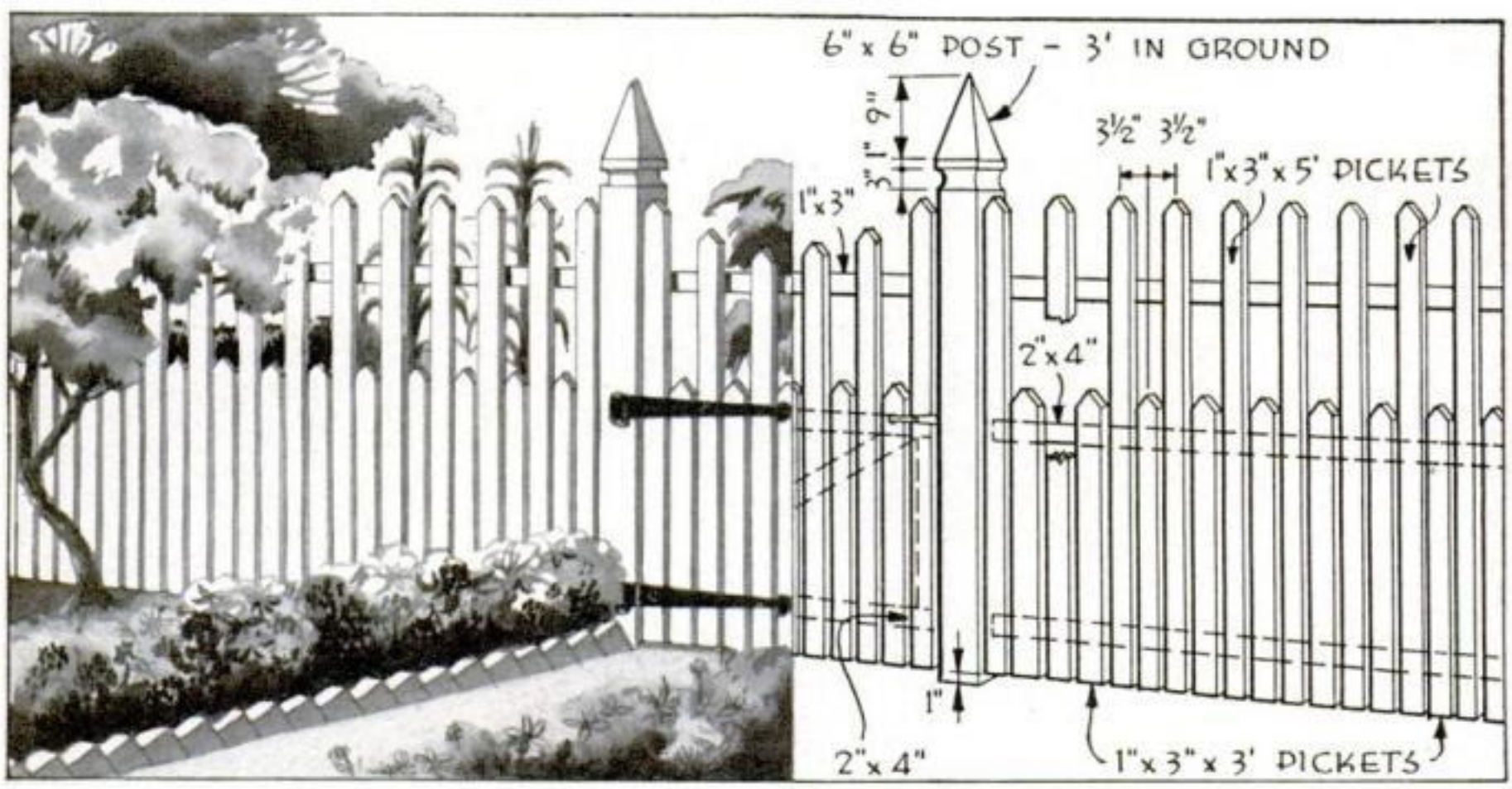



Fig. 8. Safeguard your Victory garden from invasion by alien dogs or chickens with a fence like this

# Question Bee

SAWS are made in an almost unbelievable number of shapes and sizes. Here are ten different kinds for you to identify. The majority are for cutting wood, and included among these are a cabinet saw, a pattern maker's saw, a stair builder's saw, and a dovetail saw. One saw that may puzzle you is known as a "cable saw." The remainder should be easy to recognize. Write their names in the blank spaces and check your answers against those at the bottom of the page.

1.....

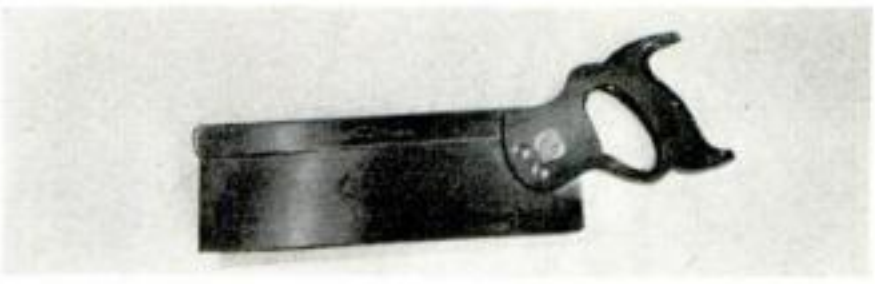
2.....

3.....

4.....

5.....

6.....



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8.....

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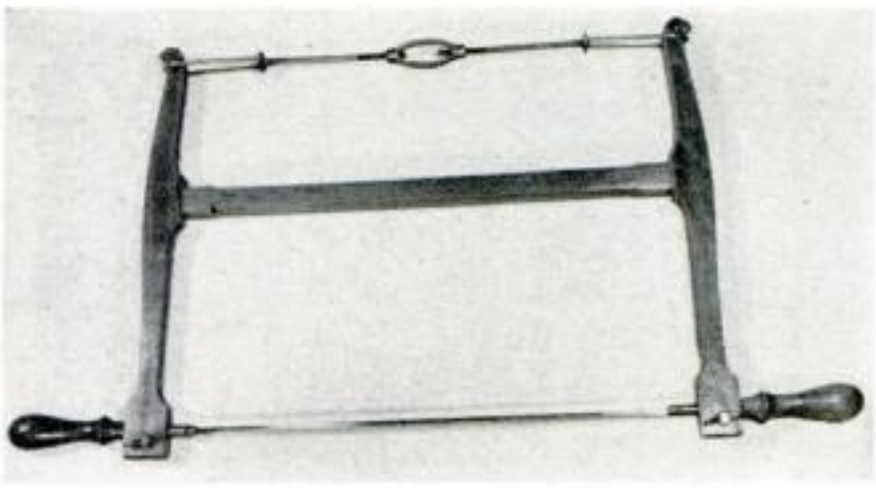


10.....

**ANSWERS**

1 Hand ice saw
2 Hack saw
3 Cabinet saw
4 Dovetail saw
5 Pattern maker's saw
6 Stair builder's saw
7 Back saw
8 Pruning saw
9 Cable saw
10 Wood saw or bucksaw

# How to Select and Season Wood

By LEONARD WILEY

AMATEUR wood turners can gain additional enjoyment from their hobby by collecting and seasoning some of their own wood. In this way they can obtain material that is difficult or perhaps impossible to buy—burls, crotches, and other beautifully grained stock. Near-by wood lots or their own back yards may yield a variety of fine blocks.

The burls of many trees are valuable, but it is necessary to distinguish between true and false burls. The latter appear where bark has grown over limb stumps, and are usually rotten inside. True burls are sound throughout. The butt cuts of logs also are a potential source of turning stock, especially those portions where the trunk flares out into the roots. Very attractive curly-grained walnut can be obtained from this part of the tree.

Forks are another source of wavy-grained and highly

Beautifully grained wood can be obtained from the bases of trees such as at the left. An excellent example is the wavy grain at the base of the walnut shown in the cross section

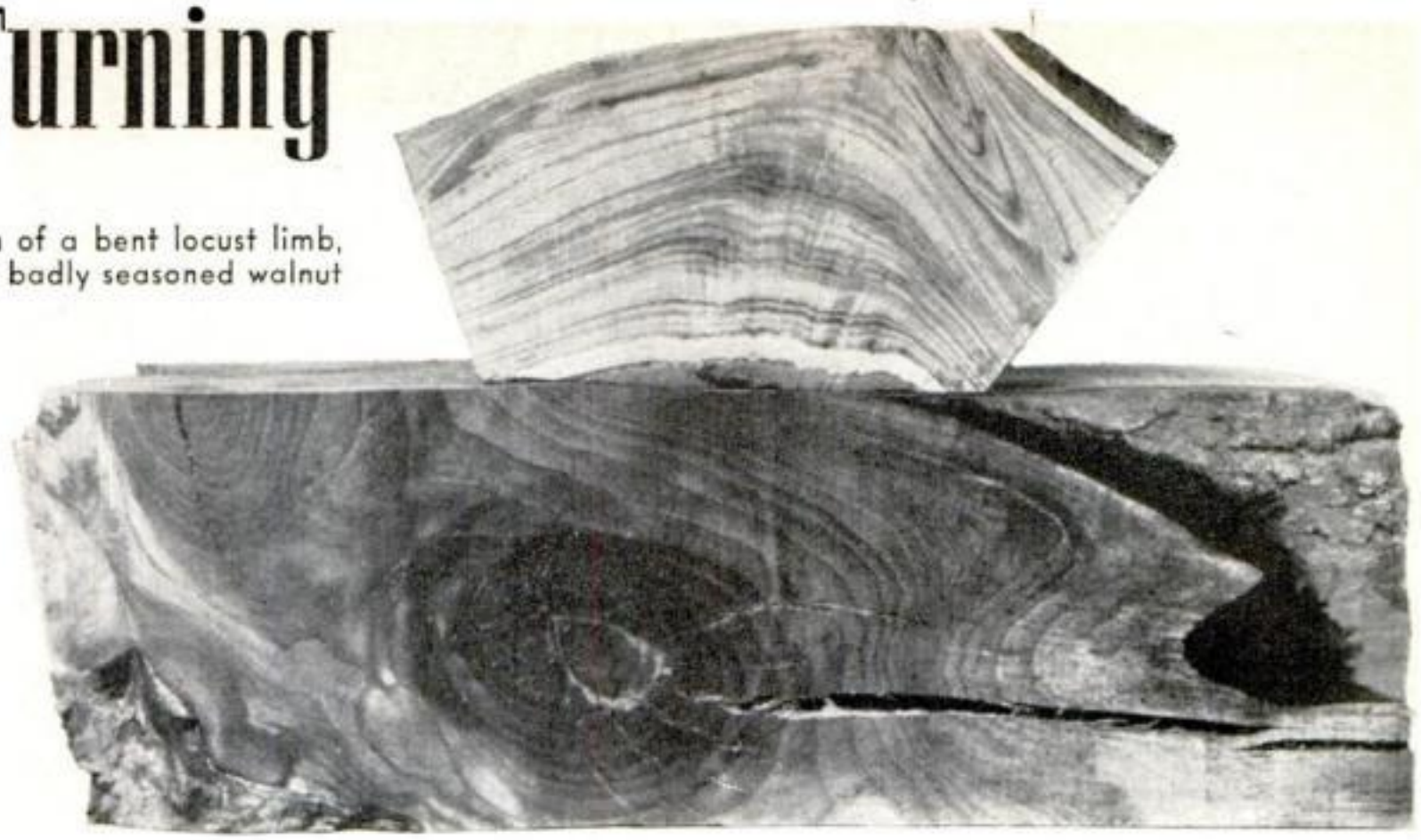
Many trees grow valuable burls, but don't be fooled by a false burl, such as the overgrown stump at the left; invariably it will have decayed inside as the walnut cross section shows





True burls are abnormal growths on the trunk and often look as at the left. The cross section of maple indicates the beauty to be expected from these burls

# for Turning



**Wavy grain** of a bent locust limb, **and, below,** badly seasoned walnut

colored wood. The inside curves of sharply bent branches such as are often found on locust trees also have wavy grain and interesting color contrasts.

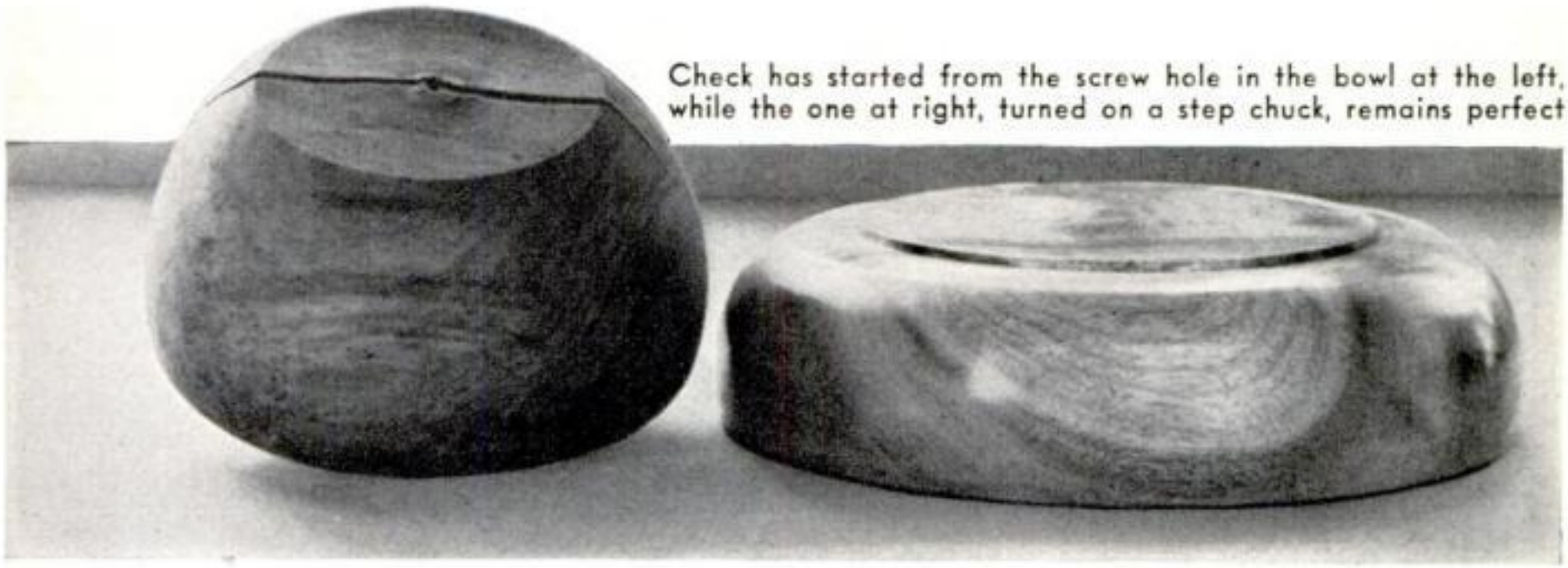
However, pieces such as these cannot be seasoned by ordinary methods without losses due to checking. If the wood is to be used within a few days after cutting, you can prevent checking by packing the blocks in wet sawdust or wet sacks. But remember, blocks left so for a great length of time may discolor, decay, or be attacked by fungi.

Green blocks may be preserved much longer in water, which should be changed once a month, but this is not suitable for small pieces of black walnut as the water tends to bleach the wood. One way to season blocks is to pack them in air-dry sawdust to which a suitable fungicide has been added. Another method is to coat them with hot paraffin. Store them in a cool place.

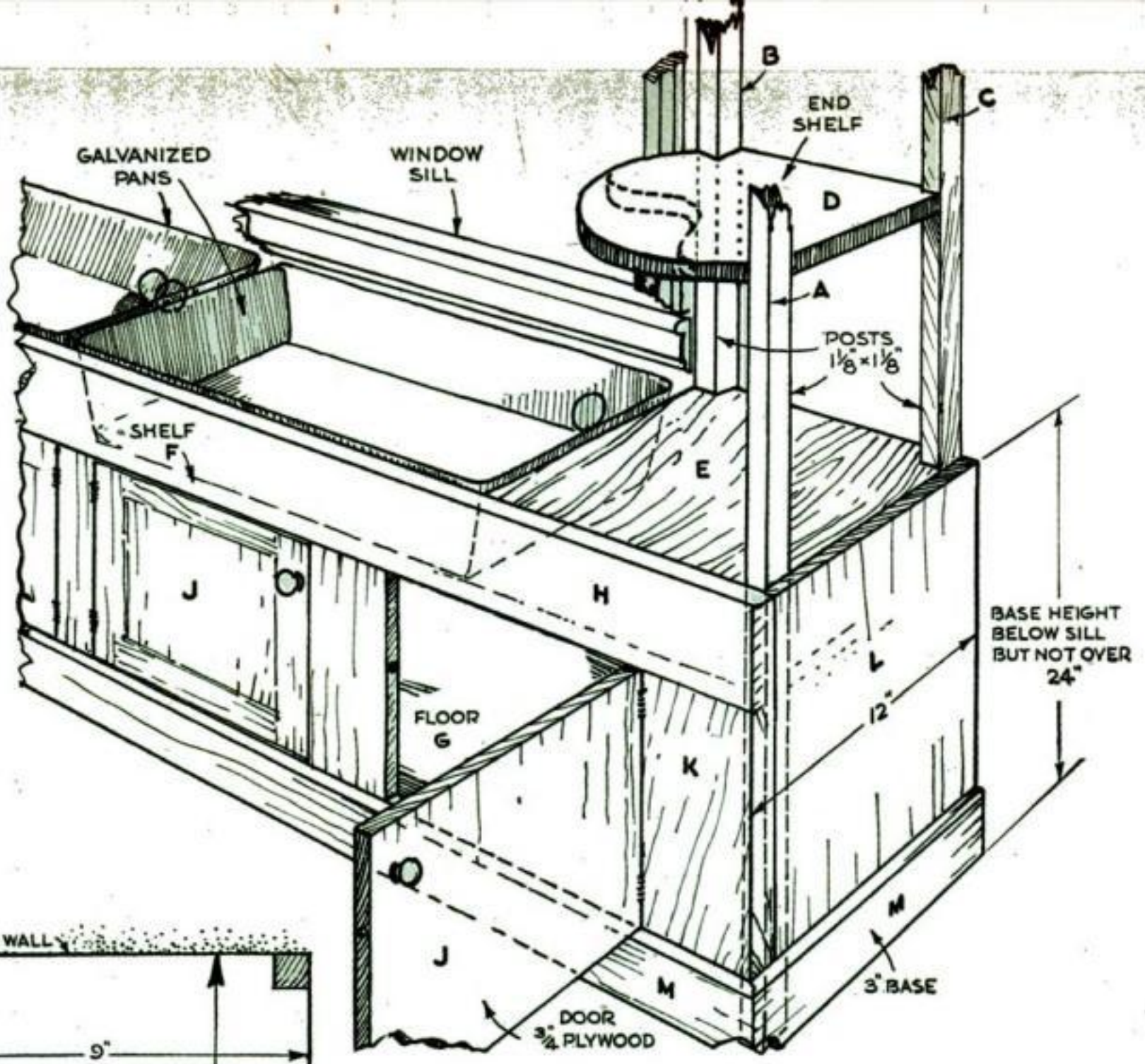
Knotty black walnut and some other woods such as plum and cherry cannot be seasoned in the form of blocks without danger of internal checking, but must be rough-turned to shape while green. It is wise to turn the block roughly to shape as soon as you can, no matter what wood you use, and to season it afterwards.

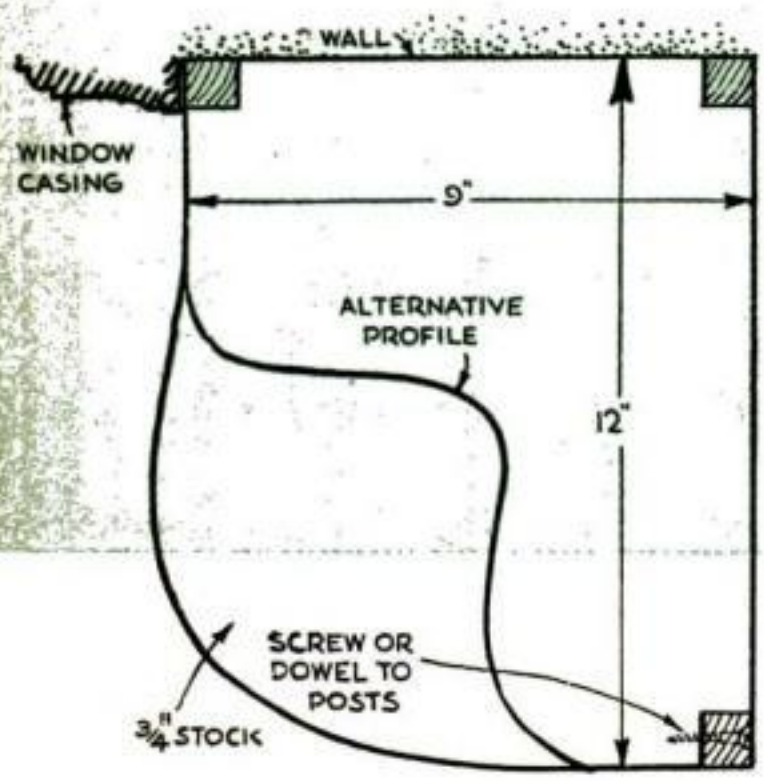
If the stock is fastened to the faceplate of the lathe with screws, the holes must be plugged with wooden pegs before it is stored for seasoning or bad checks may start from them. A good method is to mount the work with screws only for turning the outside. A flange or bead is turned on the bottom at the same time, and the piece is then pressed into a wooden chuck turned to a tight fit for it. The inside is then turned, and no screw holes will be left to cause checks.

In rough-turning a bowl, leave the stock uniformly thick at all points along the side and bottom. Use calipers for this; do not merely guess. Remember that the piece will warp when drying, and allow enough stock for truing to finished dimensions. The walls should be left from ½" thick for a small bowl to 1" thick for a large one. When thoroughly seasoned, the piece is put back on the lathe and finished.



Check has started from the screw hole in the bowl at the left, while the one at right, turned on a step chuck, remains perfect



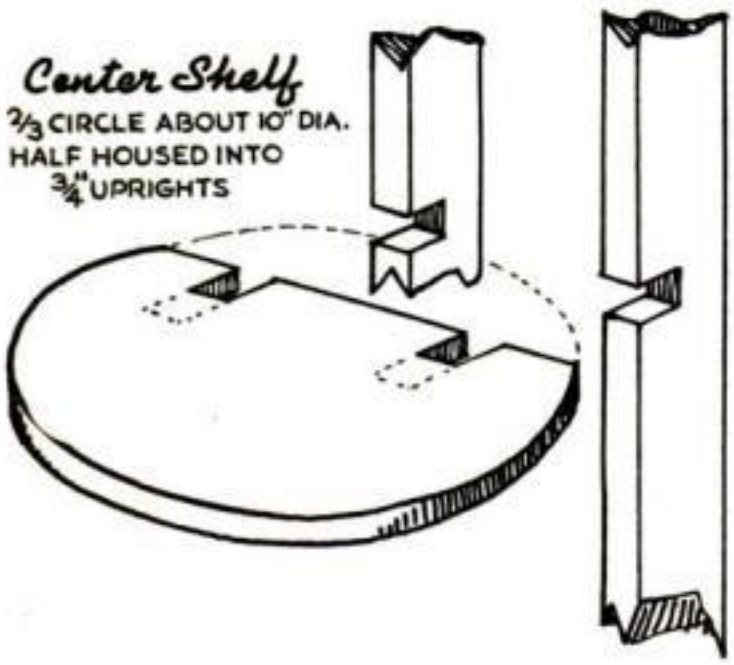

# INDOOR

**By JOSEPH ARONSON**

LIVING plants bring to a room a charm and freshness that can be enjoyed the year around. They will pleasingly frame a window or a group of windows of any size when placed on a simple base and shelves such as shown on these two pages.

It is best to choose a window without a radiator under it, and one that has good light exposure, with sunlight at least part of the day. If possible, it should be one that need not be opened for ventilation, for plants do not thrive on the sudden changes of temperature that accompany the opening and closing of windows.

The base section is built just below window-sill height, and accommodates metal pans or flower boxes. In it can be kept tools, watering cans, extra pots, plant foods, and similar supplies. A width of 12″ is suggested, but if ready-made pans or boxes are to be used, it is wise to buy them and build the base wide enough to suit. The length will depend, of course, upon the space available. If you

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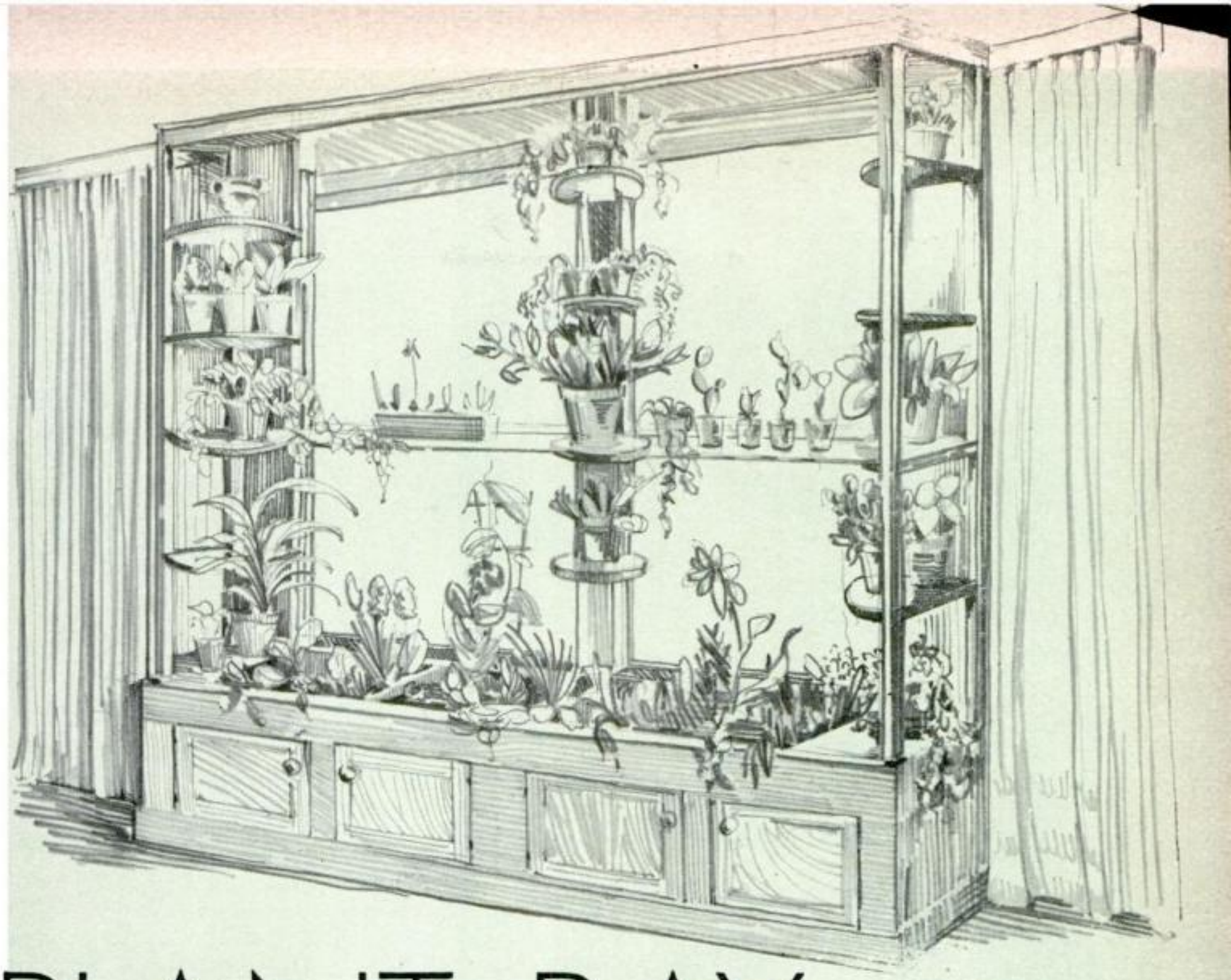


# PLANT BAY

have a double window such as the one shown, a central tier of small shelves may be added and will prove effective.

Waterproof ¾" plywood is recommended for the shelves, doors, and other wide parts. The doors may, however, be of paneled construction, if preferred. Both styles are illustrated in the drawing on the facing page. Start construction by erecting a framework of the three posts *A*, *B*, and *C*, at each end, joining these above the window frame with 1⅛" square stretchers. Dowel or screw fast the small shelves *D* far enough apart to leave the plants room to grow, and fit the floor *G* and the shelf *F*. Close in the top at each end with a piece *E*; then fit the end *L*, which extends to the edge of the inside post. The apron *H* should be about 6" wide. It is simply nailed against the edges of *F*, *A*, and *L*. The piece *K* is flush with *H*, and the door *J* is hinged to it. If more doors are required in the design, as there are here, they are fitted similarly. Finally, the baseboard *M* is nailed over the sides and front.

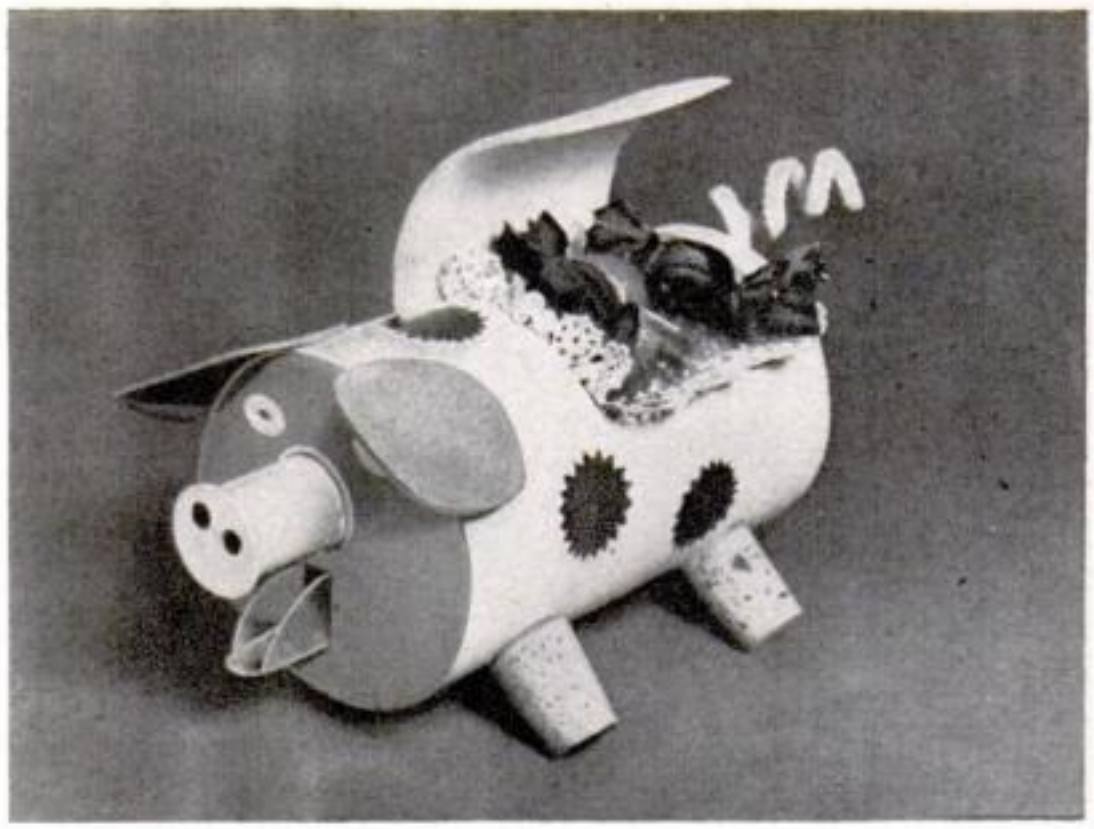
The central tier of shelves consists of segments two thirds the size of a 10" circle half-lapped into ¾" by 4" uprights, which in turn are fastened to the center post between the windows. Space the shelves to correspond with those at the ends. Glass shelves may be laid across three at the same height to support small plants.

To permit easy handling, the plant pans in the base section should not be too large. You can place plants directly in them, or else set potted plants in gravel in the pans. The latter method maintains more even moisture without danger of soaking the roots.

Paint the fixture to match the woodwork or walls of the room. See that the paint film is substantial enough to protect the wood from moisture by applying at least three coats, or more if necessary. Choose a variety of plants, including vines and other loose, flowing types that will break the straight lines of base and uprights.

## An Amusing Pig Centerpiece Made from Odds and Ends

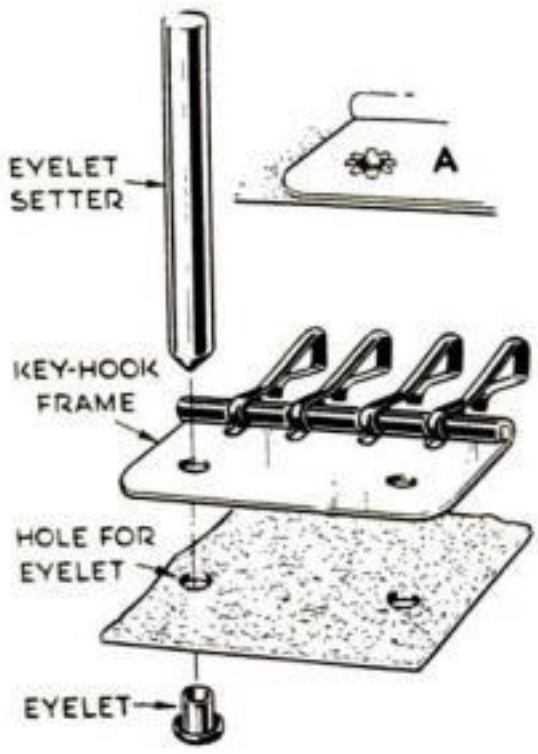
FILLED with candies or small favors, this fat little pig is good for a round of laughs at almost any party. You will need a round salt carton with a metal pouring spout which, left open, forms a very piglike mouth. Above it cement a small spool for the snout. Make the squinty eyes from notebook reinforcing rings by slicing a section out of each and flattening the circle. Stick on ears cut from an old inner tube or other thin rubber, twist a pipe cleaner for a tail, and attach gummed legal seals for the "spots." Use short, thick corks for the pig's legs.




## Chicken Bands Dress Up Notebook

POULTRY bands, used for marking the legs of chickens, make novel rings for binding loose-leaf cookbooks, notebooks, photograph albums, and the like. The celluloid markers can be obtained in a variety of gay hues, and will provide a bright, decorative touch of color. They are sure to be found particularly effective with shellacked or varnished plywood covers. They are sturdy enough to meet the requirements of ordinary use.—B. N.

## SETTING BAG PLATES and EYELETS [ *LEATHER CRAFT* ]




Bag plates come in a variety of shapes and therefore cannot be set as ordinary snap buttons. After the eyelet hole has been located and punched, place the finished side of the plate on a cloth pad and, in this order, put over it the leather, eyelet, and anvil. Strike the anvil sharply with the mallet. The spring and post are set in the customary manner as described in previous leather-craft data.

Eyelets are used to hold key-case frames in place. Locate and punch the holes as in the drawing. Place the leather over the eyelet, the key-case frame on top, and push the eyelet through. Spread the eyelet over the frame as at *A* by striking the setter with the mallet. If necessary, finish by flattening the eyelet with a hammer.

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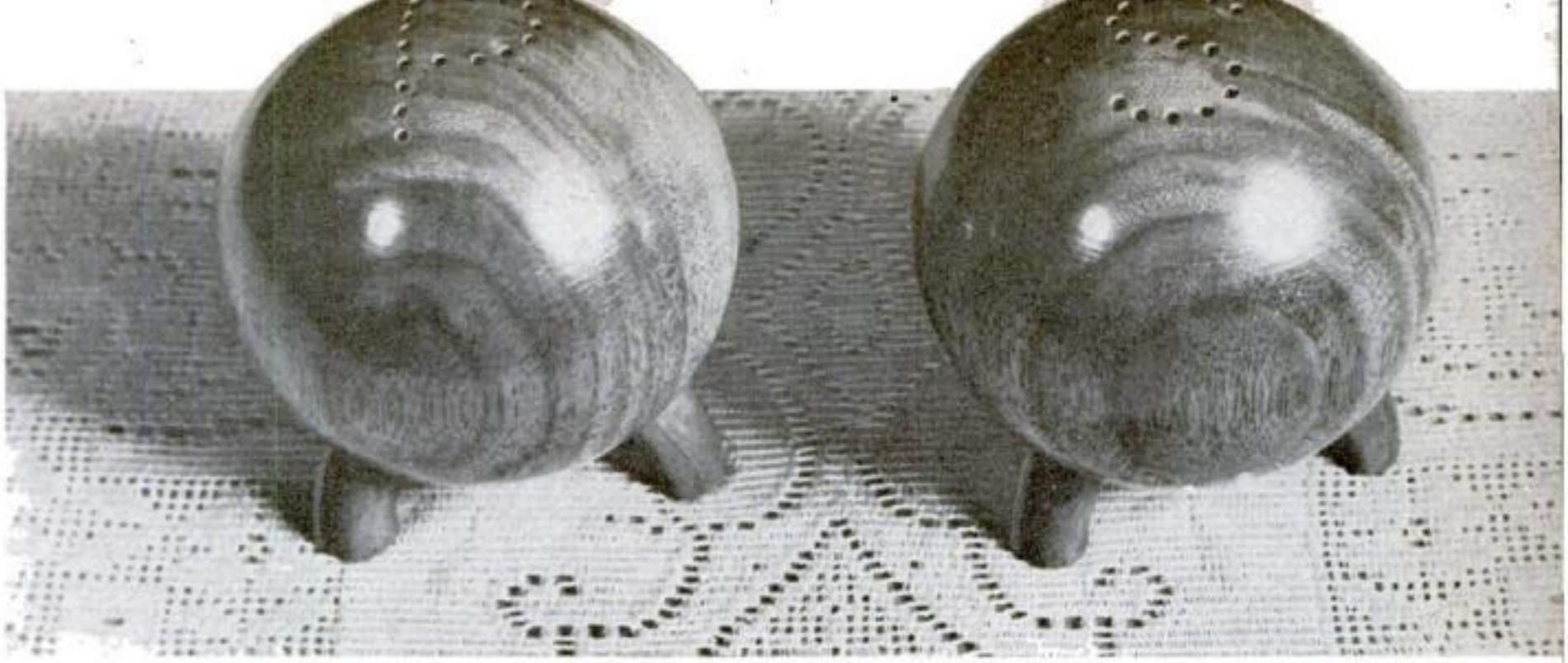
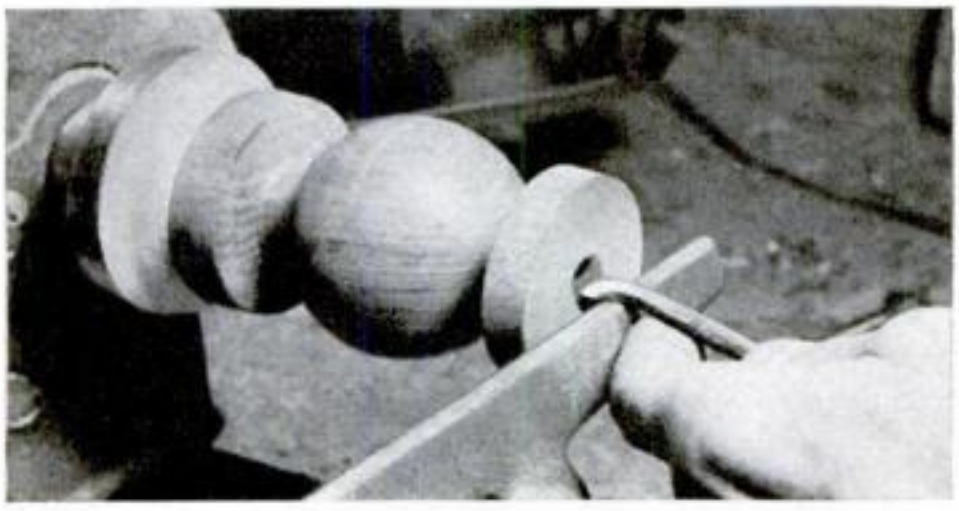
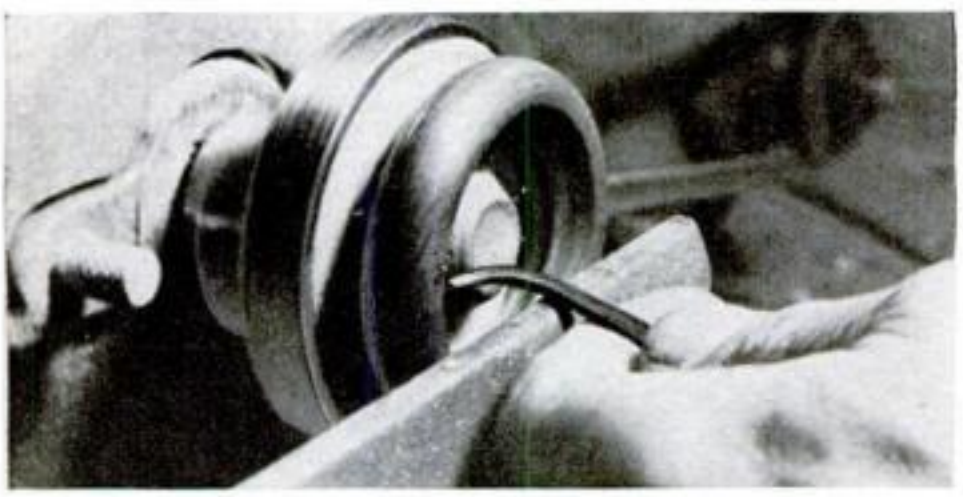


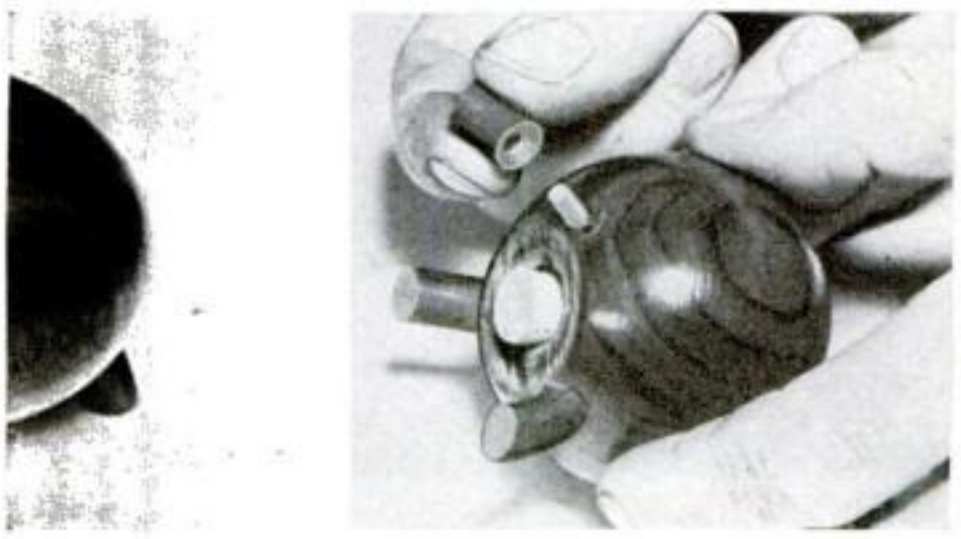
# Ball-Shaped Walnut Salt and Pepper Shakers



Balls with bases are mounted on the faceplate and hollowed with a bent tool. Bases are then cut off

Legs are made from a turned 2" ring, which is cut into six equal parts—three legs for each shaker





Holes for dowels are drilled in the bottom end of the shaker and in upper ends of the legs, which are then assembled with glue, concave side in. Corks plug the large openings in the containers

SPHERICAL in design, these attractive shakers are made from beautifully figured walnut. Turn a ball 2⅜" in diameter, but leave a base, as shown, on either end. To hollow out the ball, glue one base to a piece of scrap wood and mount on a faceplate. Start the lathe and use a 7/16" bit to bore a hole to within ¼" of the top side of the ball. For widening the central part of the bore, a bent boring tool is required; this can be made by bending an old or cheap screw driver and sharpening the point.

After hollowing out the ball, remove it from the waste stock, turn it around, glue the opposite base to scrap stock, and mount on the faceplate. Cut the top base off, smooth, and sand. Mark off the initial P or S and drill equally spaced holes, using a small drill. Now drill three equally spaced holes in the bottom part of the bowl to take the dowels by which the legs are to be attached.

Sand the wood well, apply filler, let dry, and give a coat of shellac. Before the shellac dries, take a cloth on which has been placed a little shellac, a few drops of oil, and a trace of alcohol, and hold it in contact with the ball while it is rotating at moderate speed. This gives a smooth, high polish. Remove from the faceplate and allow to dry thoroughly before cutting from the base.

For the legs, turn a ring 2" in diameter and approximately ⅜" thick. Finish this the same as the ball. Then cut it into six equal sections and bore a hole in one end of each section for a dowel. Countersink this end concave to fit against the ball, and assemble with glue.—BENJAMIN NIELSEN.

1

# Taper Turning

## HOW TO MAKE LATHE CENTERS

LATHE headstock and tailstock spindles are, of course, designed to take tapered centers. The holes are reamed to standard Morse tapers, a table of which is to be found in machine-shop handbooks and many machine-tool catalogues. Morse tapers run from No. 0 through No. 7, and it may surprise the beginner to note that the angle, or taper per foot, varies slightly through the whole range.

Figure 1 shows a set of lathe centers turned to a No. 3 Morse taper, but the drawing is dimensioned for a No. 2 taper, which is in more common use on small lathes.

There are various ways of turning a tapered piece in the lathe. For long work, where the angle of taper is slight, good results are obtained by setting the tailstock off center. Where the work is short, however, and the taper steep, this method is not accurate. Nor can it be used for boring tapered holes.

For short tapers of any angle, and for tapered holes, an effective method is to chuck the work and use the compound rest, set at the angle required.

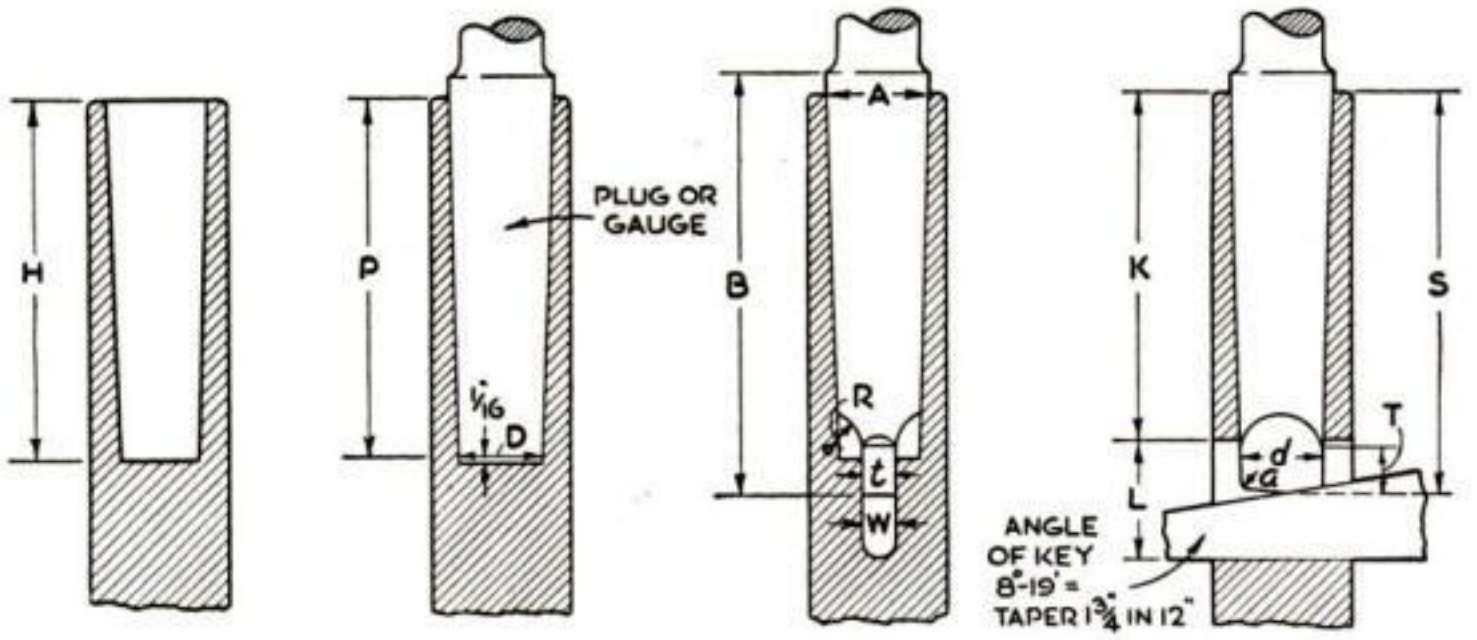
A third and perhaps better way of turning tapers is to use the taper attachment. This can be set, either for turning or for boring, to specific angles or to any desired taper per foot. Duplicate work can be turned accurately to the proper taper, whatever the length of the piece, if within the range of the attachment.

On the other hand, when the set-over tailstock method is used, the angle of the taper will, of course, vary with the length of the work. This objection may be overcome by using stock cut to identical lengths, with center holes drilled to the same depth. Under these conditions, the method has its advantages and was the one used in turning the centers illustrated.

Round tool steel was cut to 6″ lengths, each being centerdrilled at both ends, and placed between centers, as in Fig. 2, with a lathe dog mounted on the larger end to drive the work. Calculations for setting over the tailstock were made by multiplying one half of the taper per foot by the length of the work in feet—.5′ in this case. In cases where the taper extends the full length of the stock, it is customary to set the tailstock over just one half of the difference between the large and small diameters.

Trial cuts were made and the work tested

**MORSE TAPERS—DRAWINGS** [*SHOP METHODS*]

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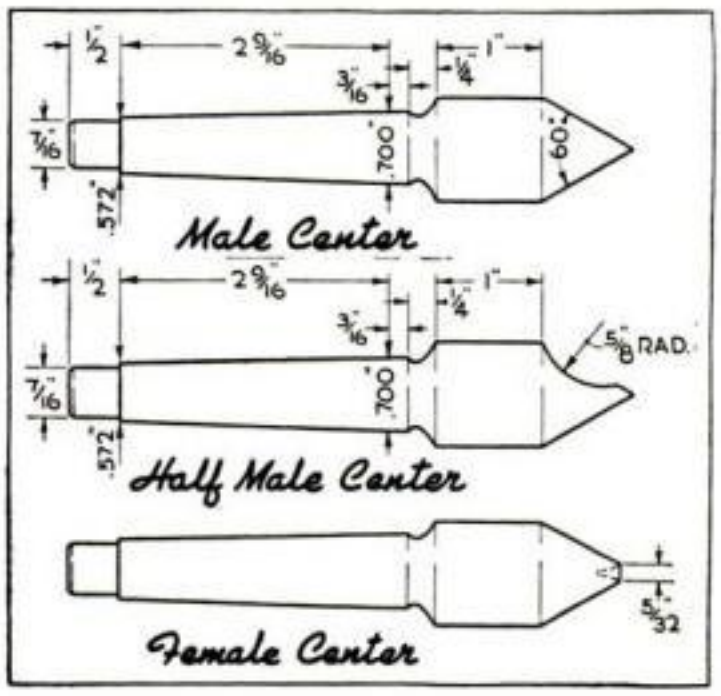
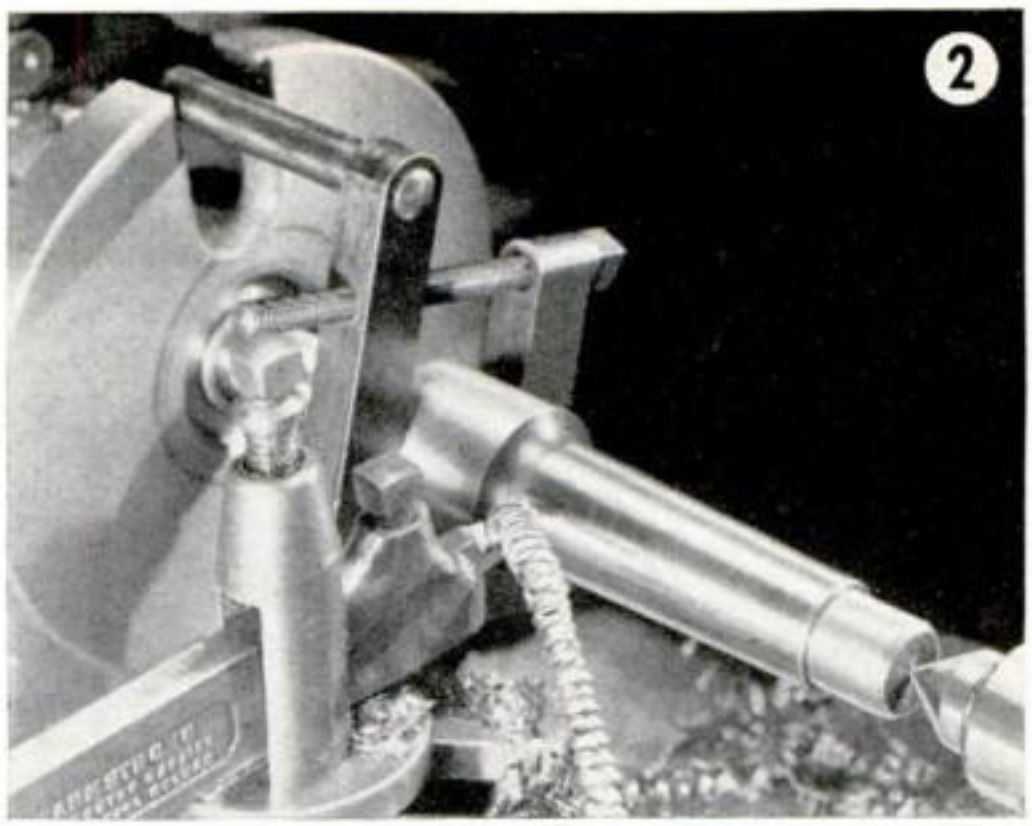
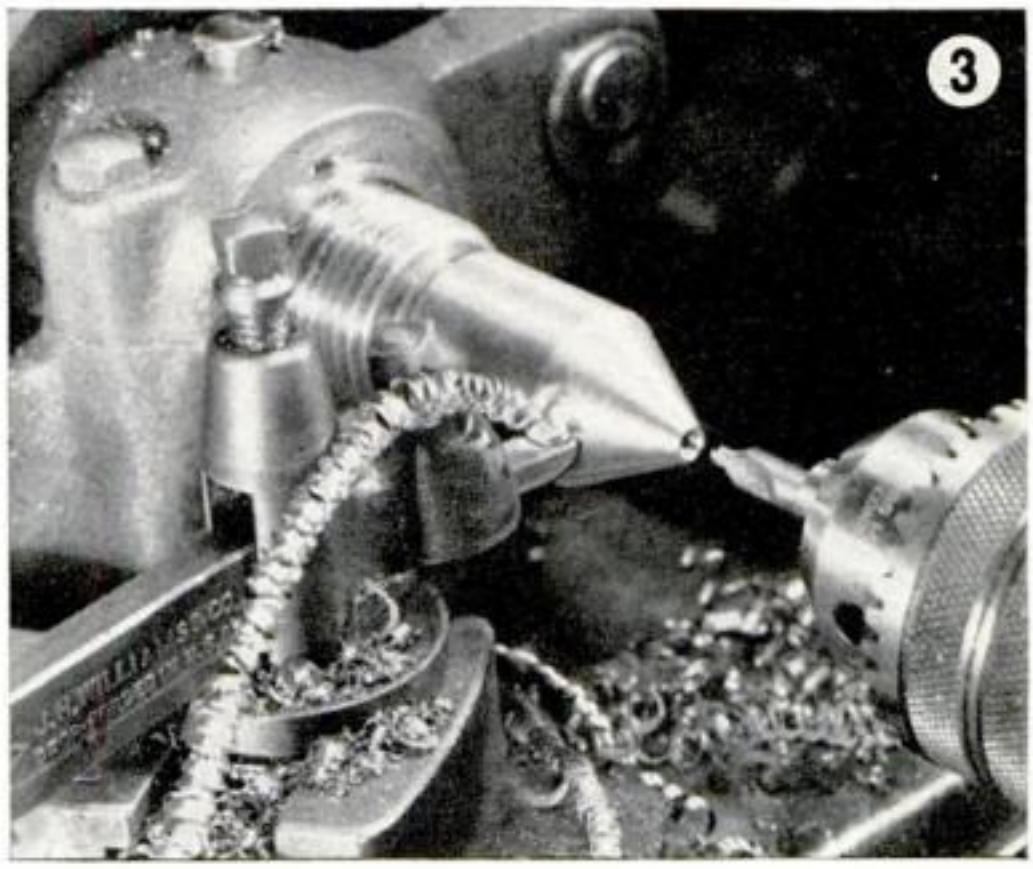
in a standard Morse taper test gauge. Tailstock readjustment and repetition of the test followed until a perfect fit was obtained. The taper was then filed smooth and polished with emery cloth and oil. After being removed from the centers, the piece was slipped into the headstock spindle hole, the compound rest set to an angle of 30 deg., and the center point turned to shape.

The female center was left blunt on the end and centerdrilled (Fig. 3) with a combination center and countersink drill. The half male center was cut away and filed.

As all three centers were for use in the tailstock of the lathe, they were hardened by heating to a cherry red and quenching in oil, the temper being slightly drawn by burning off the oil.



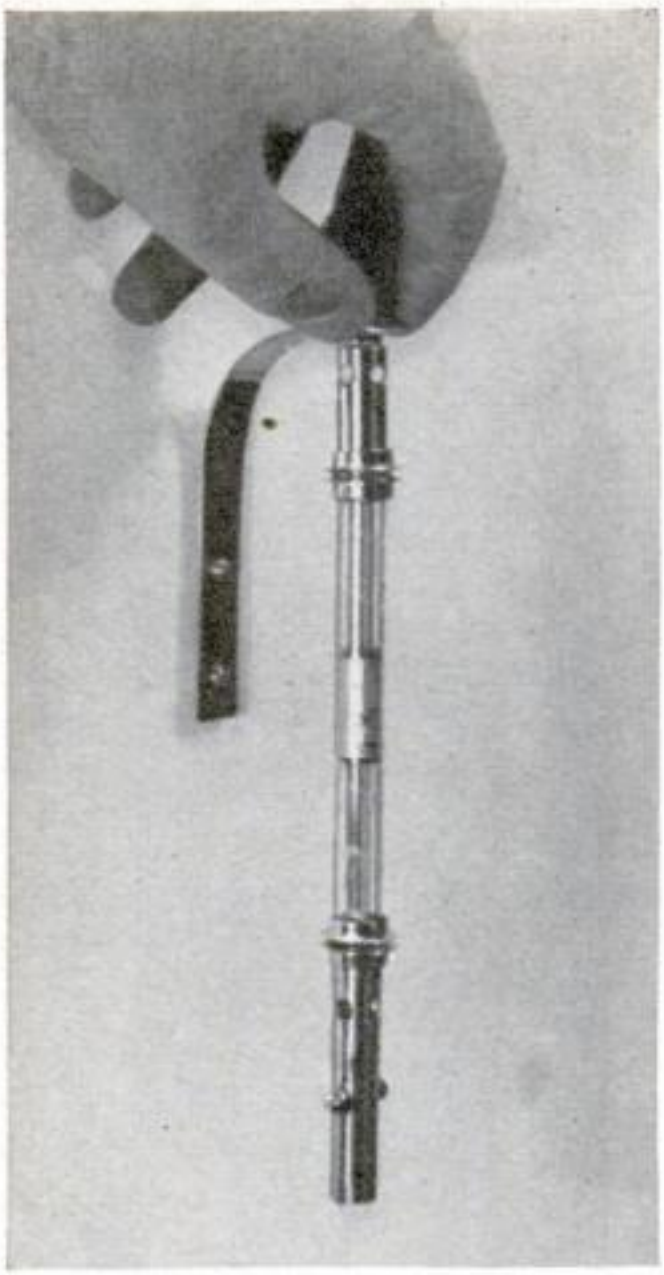

## MORSE TAPERS

[SHOP METHODS]

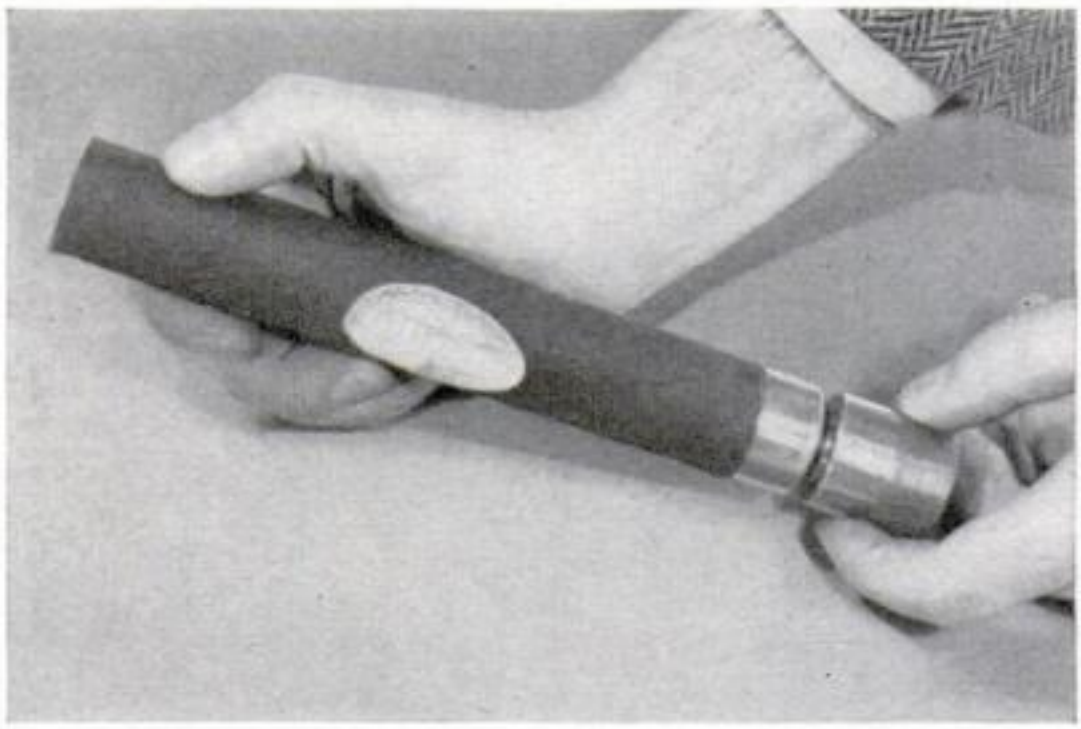
| Number of Taper | Diam. of Plug at Small End, Inches | Diam. at End of Socket, Inches | SHANK | | Depth of Hole, Inches | Standard Plug Depth, Inches | TONGUE | | | | | KEYWAY | | | Taper per Foot | Taper per Inch | Number of Key |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Whole Length of Shank, Inches | Shank Depth, Inches | | | Thickness of Tongue, Inches | Length of Tongue, Inches | Rad. of Mill for Tongue, Inches | Diameter of Tongue, Inches | Radius of Tongue, Inches | Width of Keyway, Inches | Length of Keyway, Inches | End of Socket to Keyway, Inches | | | |
| | D | A | B | S | H | P | t | T | R | d | a | W | L | K | | | |
| 0 | .252 | .3561 | 2 11/32 | 2 7/32 | 2 1/32 | 2 | 3/32 | 1/4 | 5/32 | .235 | .04 | .160 | 9/16 | 1 15/16 | .62460 | .05205 | 0 |
| 1 | .369 | .475 | 2 9/16 | 2 7/16 | 2 3/16 | 2 1/8 | 11/64 | 3/8 | 3/16 | .343 | .05 | .213 | 3/4 | 2 1/16 | .59858 | .04988 | 1 |
| 2 | .572 | .700 | 3 1/8 | 2 15/16 | 2 5/8 | 2 9/16 | 1/4 | 7/16 | 1/4 | 17/32 | .06 | .260 | 7/8 | 2 1/2 | .59941 | .04995 | 2 |
| 3 | .778 | .938 | 3 7/8 | 3 11/16 | 3 1/4 | 3 3/16 | 5/16 | 9/16 | 9/32 | 23/32 | .08 | .322 | 1 3/16 | 3 1/16 | .60235 | .05019 | 3 |
| 4 | 1.020 | 1.231 | 4 7/8 | 4 5/8 | 4 1/8 | 4 1/16 | 13/32 | 5/8 | 5/16 | 31/32 | .10 | .478 | 1 1/4 | 3 7/8 | .62326 | .05193 | 4 |
| 5 | 1.475 | 1.748 | 6 1/8 | 5 7/8 | 5 1/4 | 5 3/16 | 5/8 | 3/4 | 3/8 | 1 13/32 | .12 | .635 | 1 1/2 | 4 13/16 | .63151 | .05262 | 5 |
| 6 | 2.116 | 2.494 | 8 9/16 | 8 1/4 | 7 3/8 | 7 1/4 | 3/4 | 1 1/8 | 1/2 | 2 | .15 | .760 | 1 3/4 | 7 | .62565 | .05213 | 6 |
| 7 | 2 750 | 3.270 | 11 5/8 | 11 1/4 | 10 1/8 | 10 | 1 1/8 | 1 3/8 | 3/4 | 2 5/8 | .18 | 1.135 | 2 5/8 | 9 1/2 | .62400 | .05200 | 7 |

POPULAR SCIENCE MONTHLY SHOP DATA

# IDEAS for HOME OWNERS

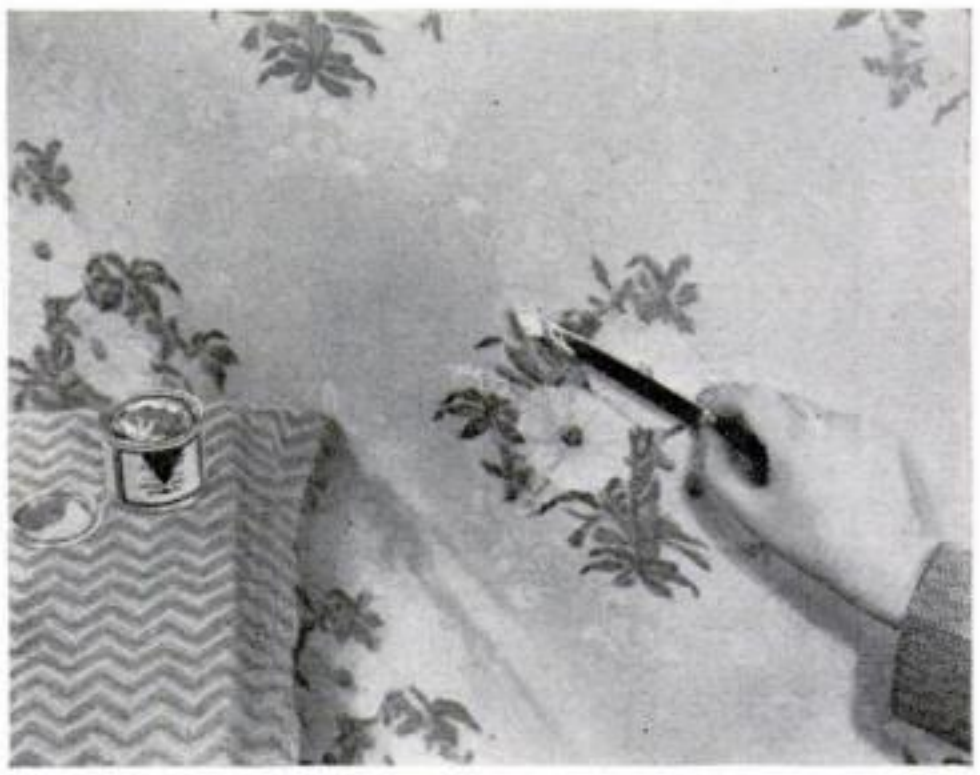


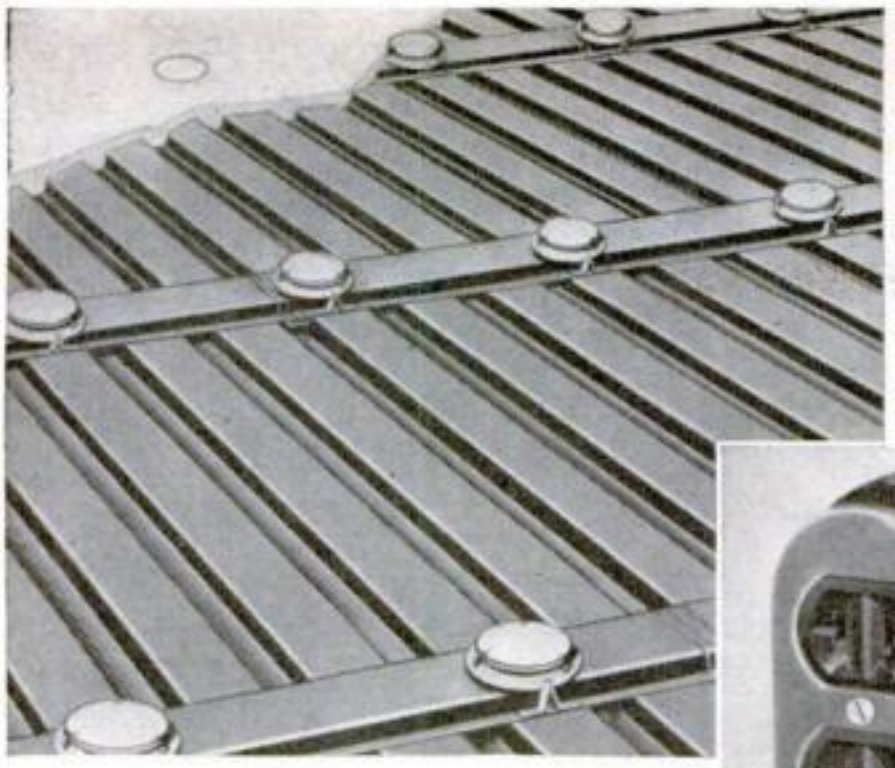
**WEATHER FORECASTING** at home is possible with a simplified instrument recently put on the market. About the size of a fountain pen, the so-called "weather glass" hangs by a bracket outside a window, and is conveniently marked for reading from indoors. There are two sections of colored liquid in the tube, and reasonably accurate forecasting for 12-hour periods can be done by noting the position of the gap between them and keeping a record regularly.



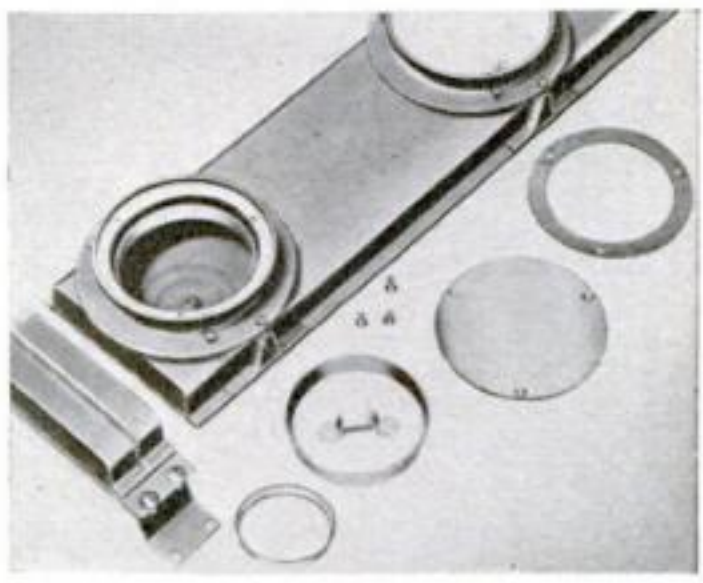
**THIS AUTOMATIC SHUT-OFF NOZZLE** stops the flow of water when a hose is dropped or otherwise straightened out at the section adjacent to the outlet end. To start the flow again, the hose is flexed slightly, as is naturally done when it is held in the hand for use. The nozzle is attached to the end of the regular hose line, and consists of an automatic valve fitted into a short extra length of heavily constructed hose. All metal parts are of rustproof metal. For car washing and similar jobs, where the hose is likely to be dropped during the course of the work, the new nozzle will be found of special value, because the flow stops instantly. A nozzle on the same principle is made for use with compressed air for various workshop and industrial purposes.

**GREASE ON WALLPAPER** can be removed with a new cleaning paste without damage to the color or design. The paste, which is a light yellow, is applied to the spot with the blade of a putty knife or any ordinary, blunt-end, table knife until the soiled place and some of the clean paper adjacent is completely covered. It absorbs the grease and draws it out of the paper as it dries to a white powder; then it can be brushed off. The cleaner may be used also on painted walls and on clothing, upholstery, rugs, and the like without harming the fabric, and is suitable for removing olive oil, butter, bacon grease, machine oil, and similar stains.



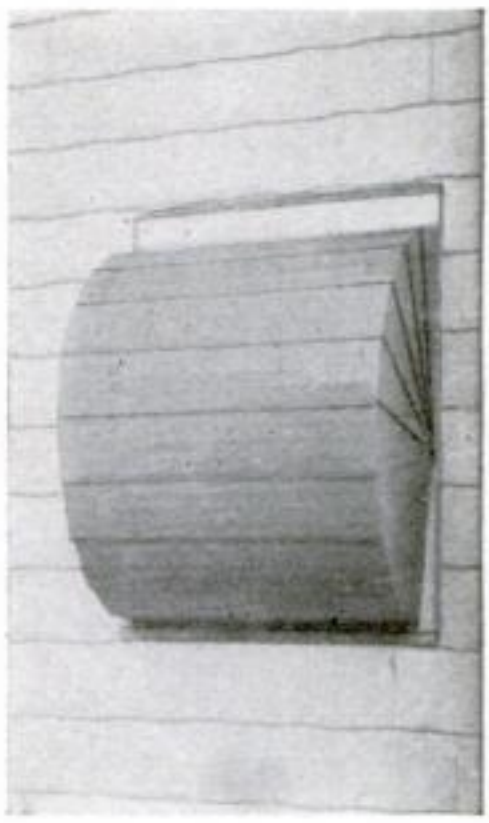


**FLOOR-WIRING HEADER DUCTS** and other accessories are available for use with hollow cellular-steel flooring. The ducts, or feeders, carry wires to the individual cells, which form natural raceways and are installed at right angles as shown. Special outlets may be attached directly to the cells by means of taps, making almost the entire floor available for electric service.

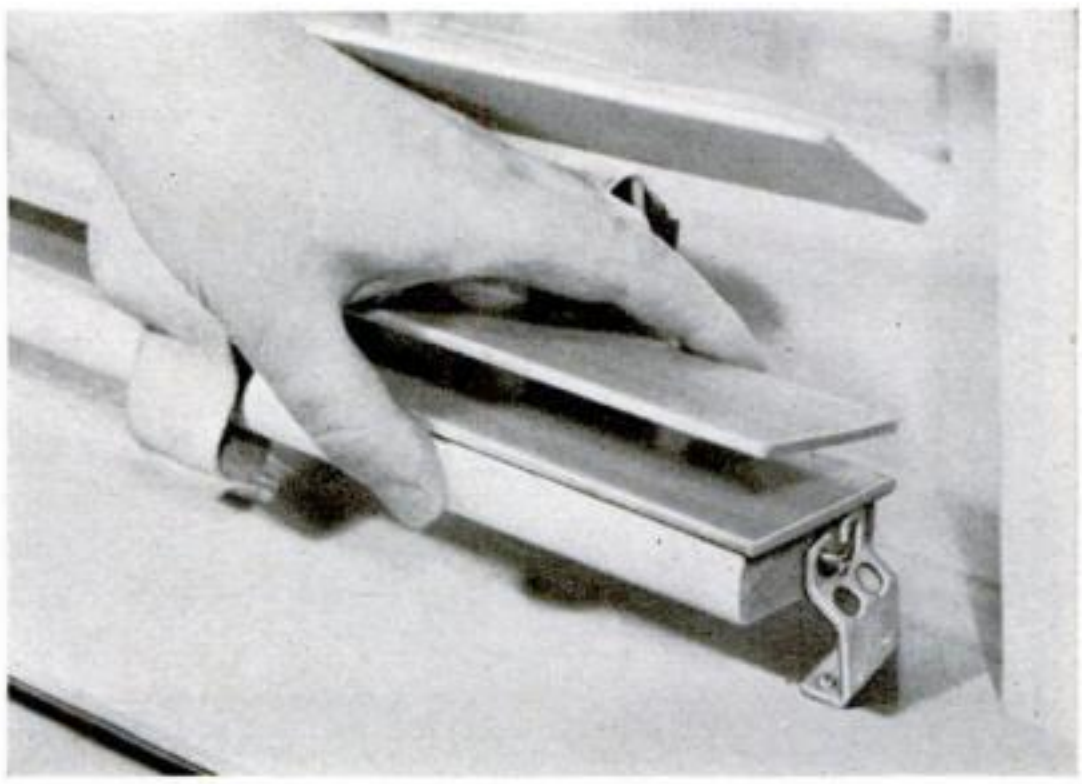


Standard header ducts carrying feeder wires to raceways are installed, as above, on top of cellular flooring. At the extreme right is a close-up of a junction unit; at center, an outlet

**FOR BLACKOUT USE,** a new type of awning has been developed, and it is claimed to have certain advantages for ordinary use as well. Raised halfway, it serves as an effective and good-looking protection against bright sunlight; and lowered, it can be locked from within to guard against prowlers in addition to its primary purpose of blacking out all window light at night. The awning is constructed of rustproof material, is fireproof, and will minimize—in many cases eliminate altogether—the shattering of glass windows by concussion, flying debris, or fragments from exploding bombs.



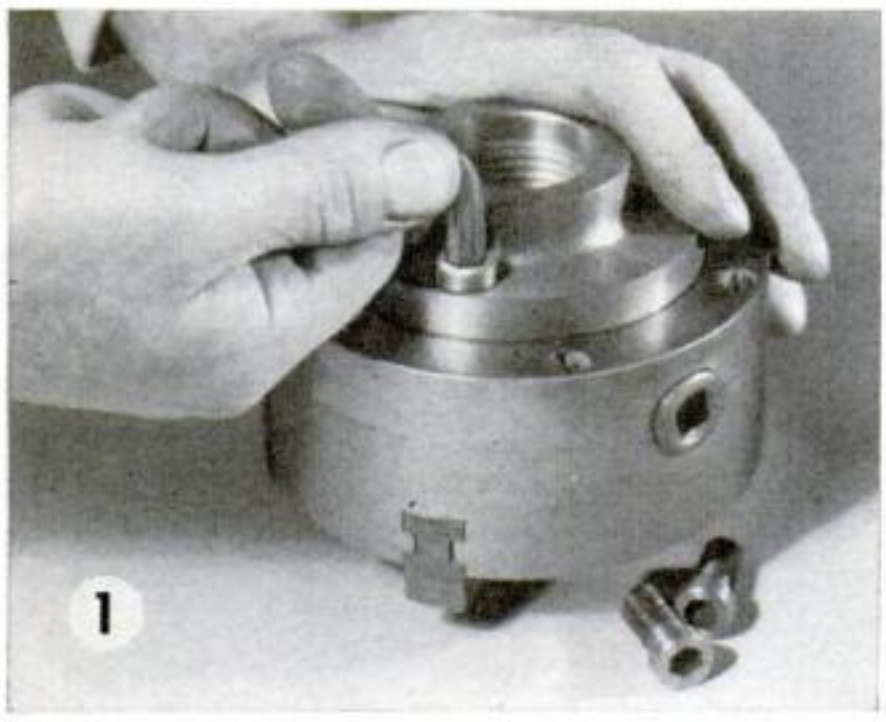
**VENETIAN BLINDS** may be anchored to the bottom sill by the installation of a new, simple fastener of the hook type. This efficient little lock consists of two parts, a bracket with hooked eyes which is attached to the window sill or the casing at the sill, and a screw inserted in the end of the bottom bar of the blind to engage the hook. Two of these catches, one installed at each side of a blind, are sufficient to keep it from blowing out in a strong wind or swaying and rattling in gusty weather. They also offer some protection against flying glass from a broken pane.



# Fitting a Chuck to Your

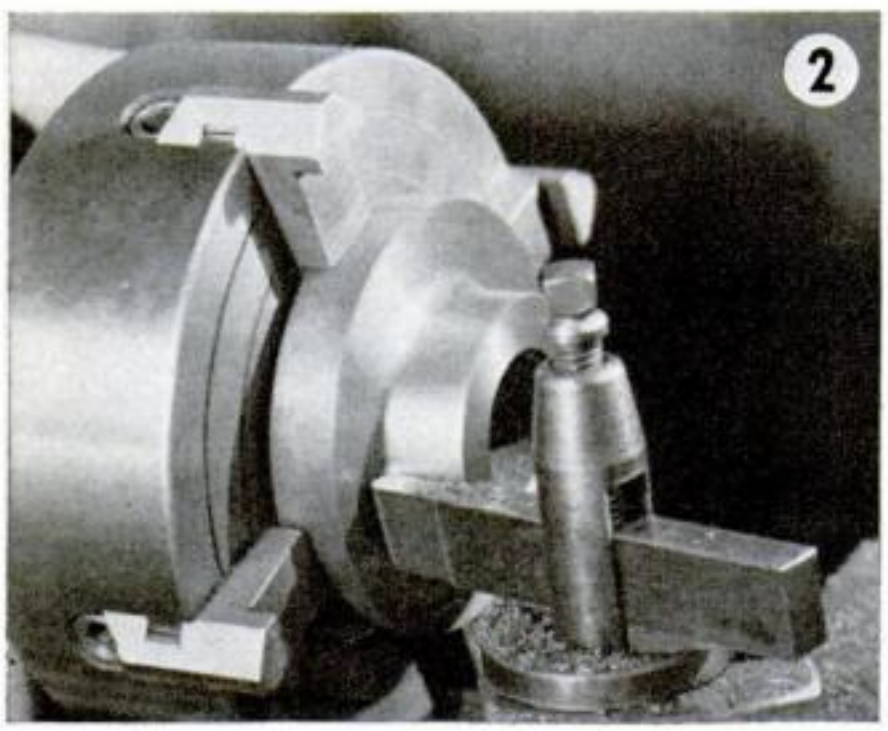
By
C. W. WOODSON

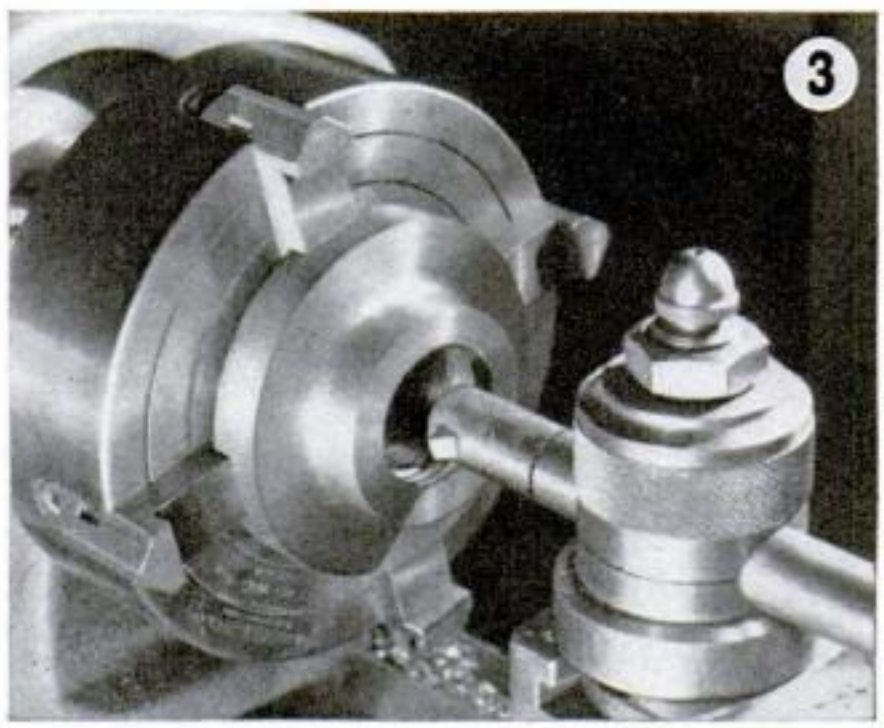
MACHINISTS FOR WAR WORK

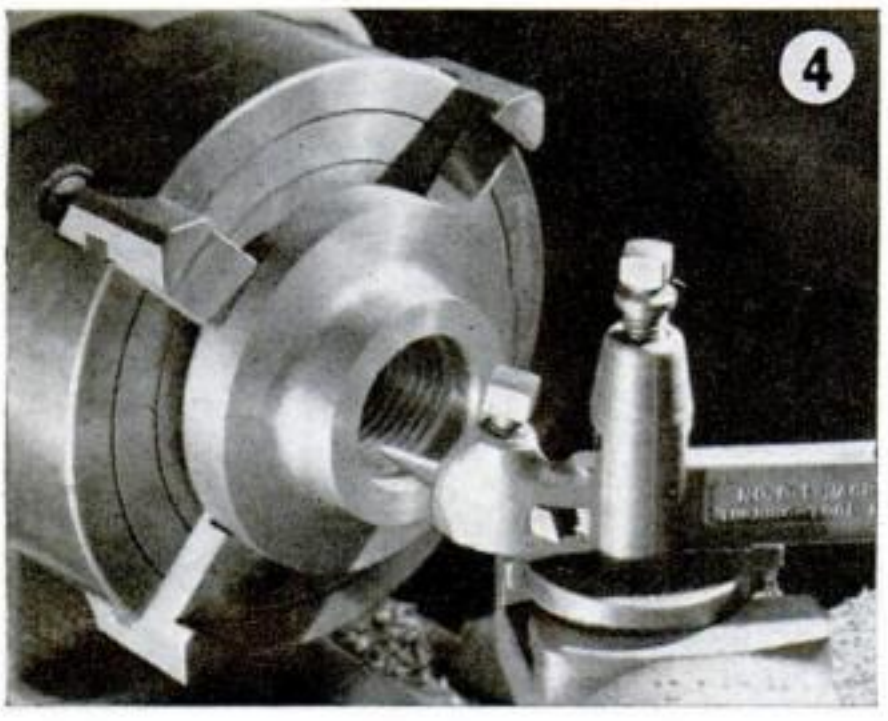


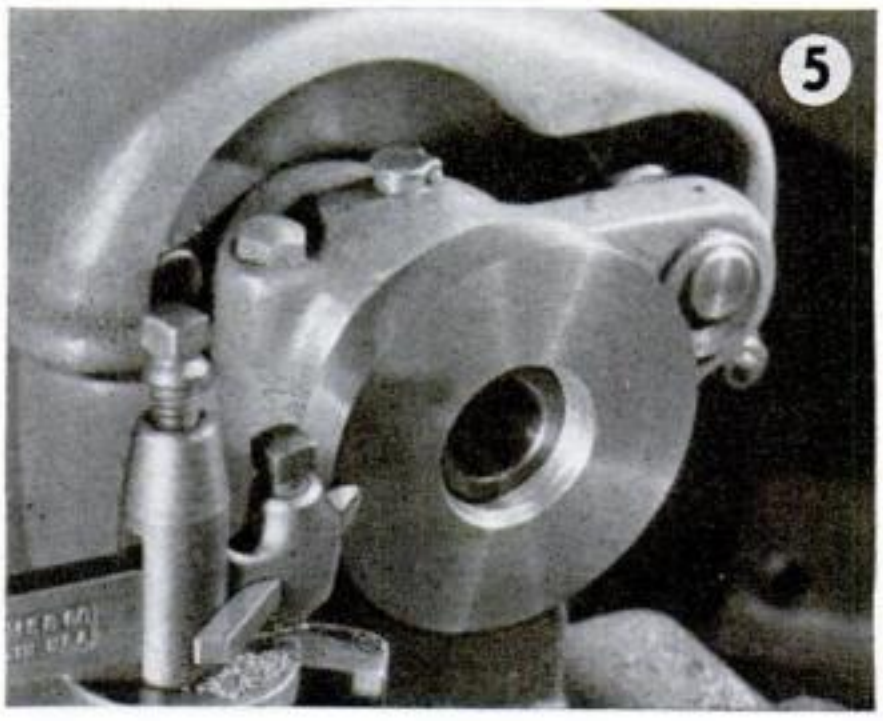

SOME lathe chucks have bodies threaded to fit the spindle, whereas others are recessed to receive a separate chuck plate or adapter (Fig. 1) that can be fitted to the lathe in the shop and permits chucks of various sizes to be used. In fitting a chuck to a lathe, the adapter must fit the threaded spindle nose accurately if the chuck is to run dead true. Although this is a precision job, it is a comparatively simple one.

Typical dimensions for a small adapter to be made from a casting are given in the accompanying drawing. These can be changed in any instance, of course, to suit the lathe spindle and chuck with which the piece is to be used. The casting is first chucked as in Fig. 2, and the back turned true and smooth. It is then bored to size and accurately threaded to fit the spindle nose, as in Fig. 3. Before the finishing cuts are made, the threads are tested for size by removing the chuck from the spindle and screwing the adapter plate, while still held in the chuck, onto the spindle, which serves



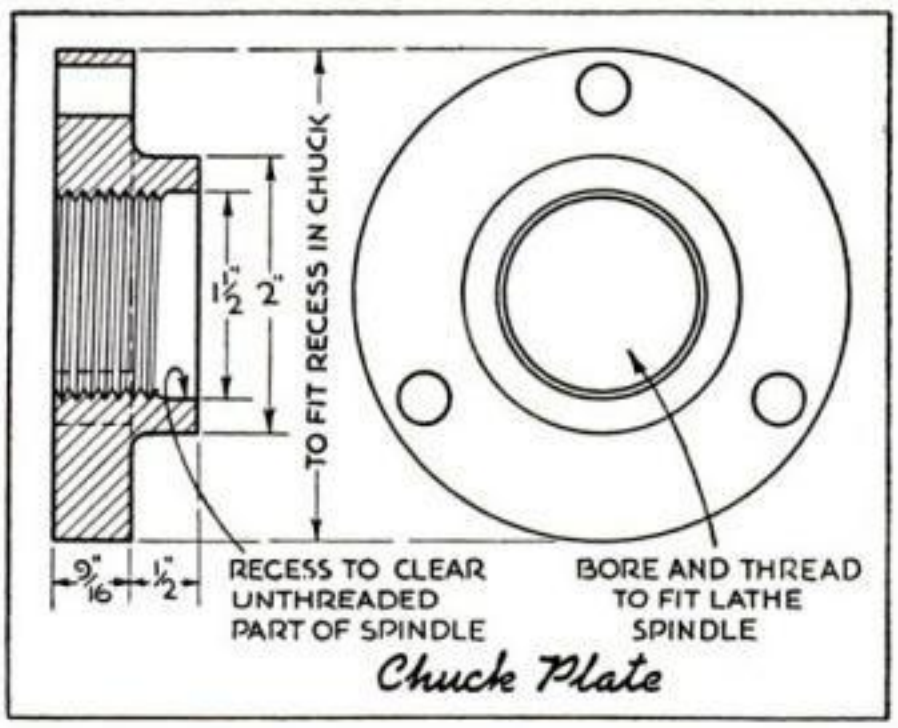



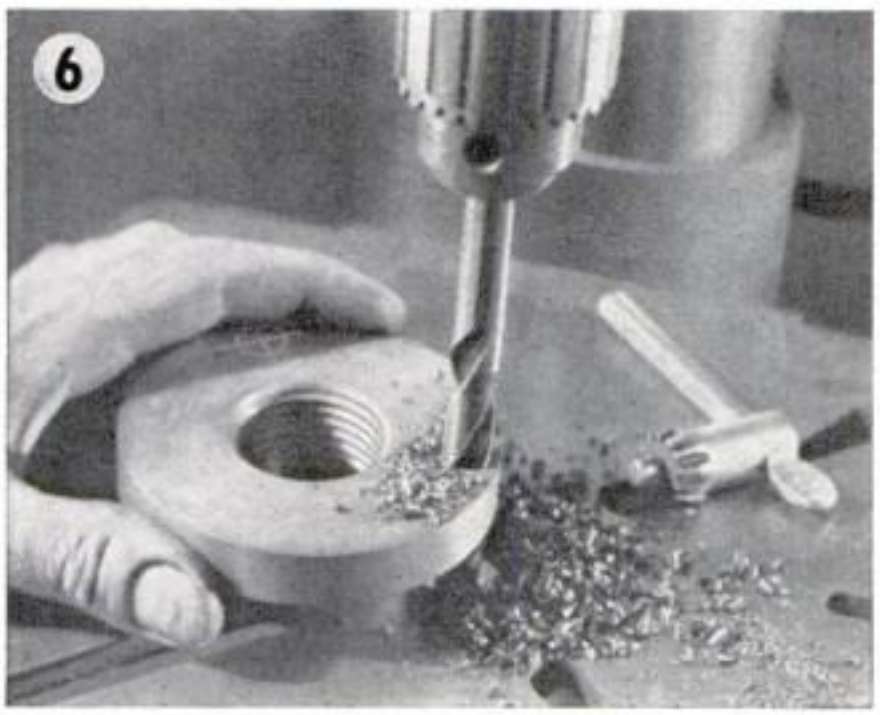
# Lathe

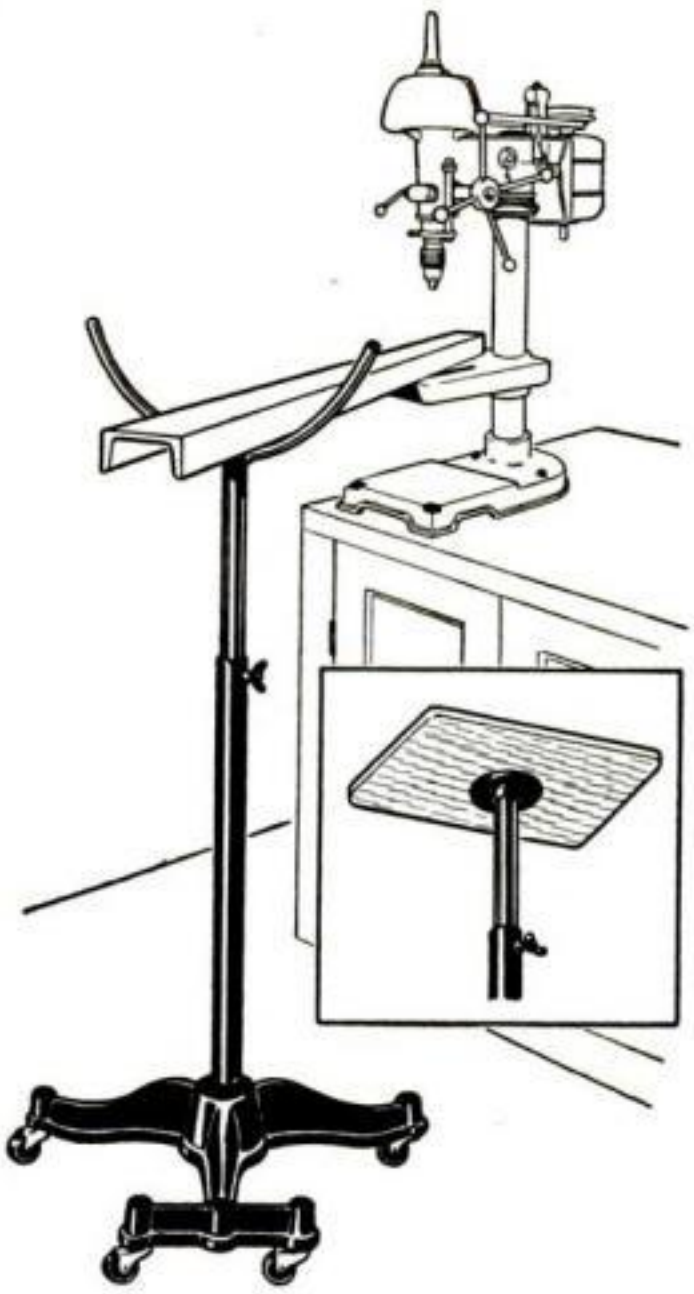
as a plug gauge to check the fit. The chuck is remounted for the final threading cuts. Two or three threads are cut back to form a recess (Fig. 4) in order to clear the unthreaded part of the nose and allow the plate to screw firmly against the spindle collar. This part of the chuck plate may be made an exact duplicate of the corresponding part of the small faceplate furnished with the lathe.

The casting is then mounted directly upon the lathe spindle as illustrated in Fig. 5, faced smooth, and its diameter turned to a snap fit in the recess in the back of the chuck. Rub chalk over the face when these operations have been completed, and insert the plate in the chuck back, striking it with a soft hammer to transfer the location of the necessary screw holes. Lay these out, center-punch them, and drill through the adapter plate (Fig. 6). After the adapter has been screwed fast in the chuck recess (Fig. 1) the chuck is ready to be screwed onto the lathe spindle and be put into use.



Chuck Plate



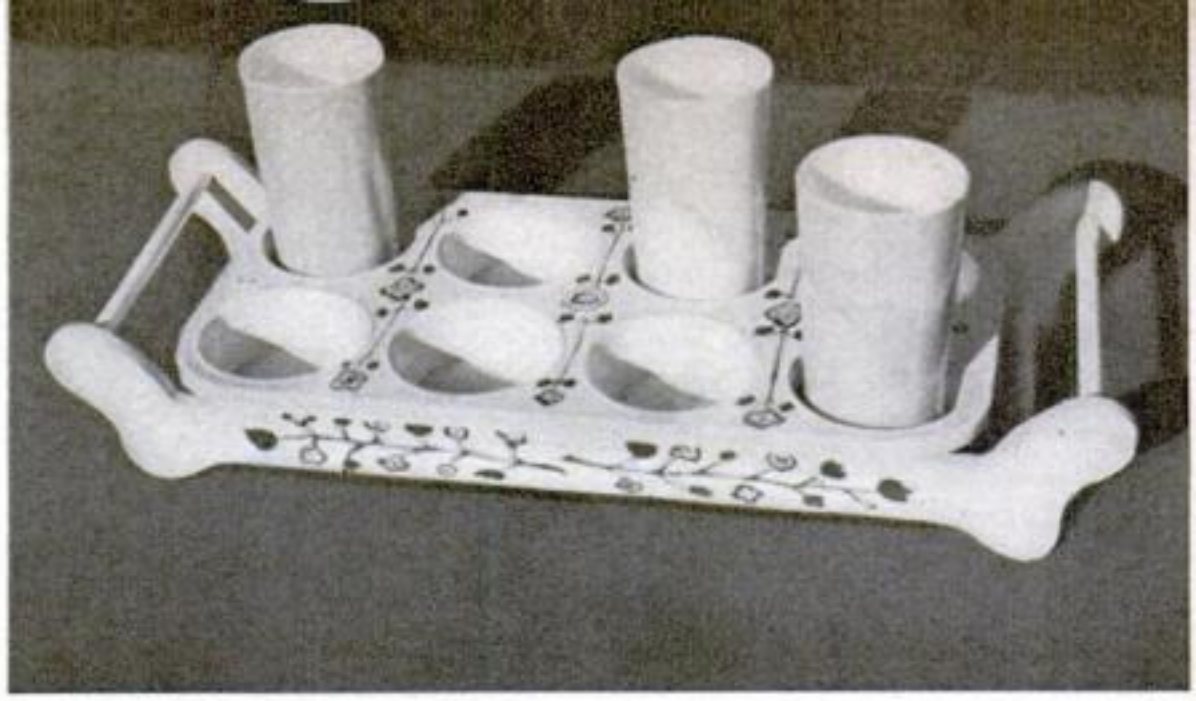



## Portable Stand for Shop Constructed from Junk

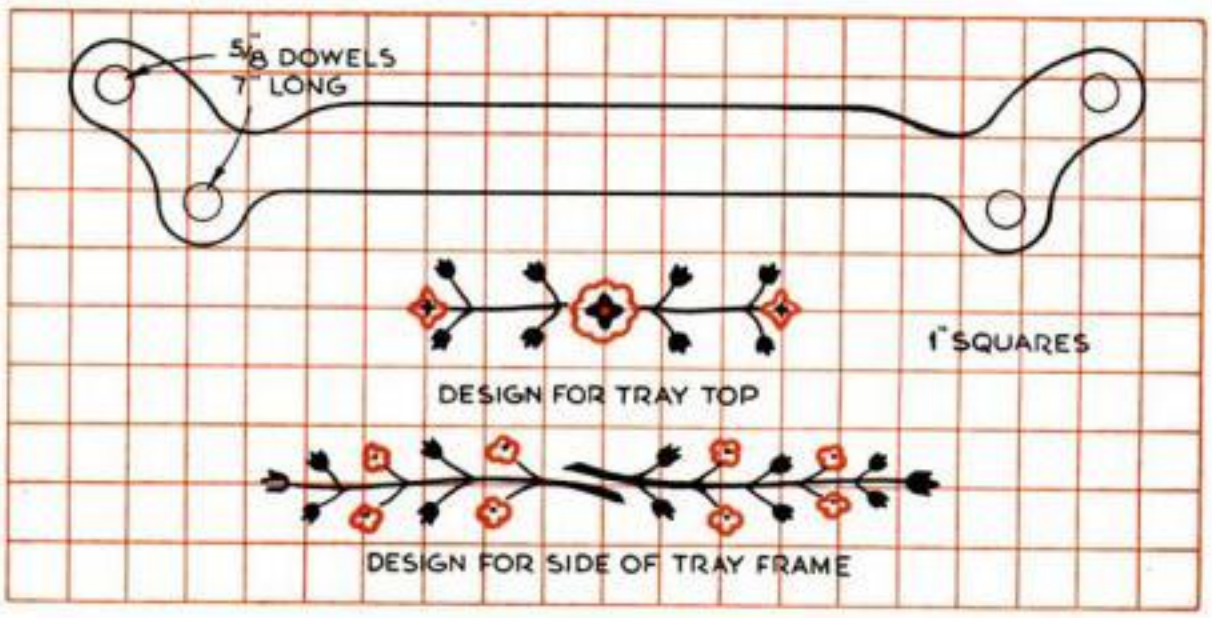
FOR an adjustable, portable stand that will support the end of long, unwieldy stock and otherwise find many uses in practically any shop, search in a near-by junk yard for a cast-iron base mounted on casters. Almost as good and still cheaper is a plain, round, iron base from an old filling-station oil sign. These are usually tapped for pipe thread.

A section of 1¼" conduit, into which a 1" pipe or conduit will telescope, is ideal for the standard. Drill a hole near the top of the larger conduit and braze on a nut to accommodate a setscrew. Several arrangements are possible for the upper section. For one which will find many uses, weld or screw a short length of ½" pipe across the end of a 1" pipe, and bend the ends upward to form a cradle. A small table top may be attached to another pipe for a temporary, portable tool holder. Both are illustrated above.—PERRY HYAMS.

Cooling drinks are served attractively on this fresh-looking tray. It's a common muffin tin, painted gaily and fitted into a matching wooden frame



# Muffin-Tin Beverage Tray




A COMMON muffin tin steps out into society in the guise of an attractive tray for serving cool summer drinks. Transformed with enamel and an easily made wooden stand, it has ready-made tumbler cups deep enough to minimize any danger of tipping.

Any large muffin tin may be used. The frame dimensions given are for an eight-cup one. However, as tins may vary a little, it is advisable to obtain the tin first, and build the frame to fit.

The tray frame consists of two wooden sidepieces put together with four dowel sticks. The sidepieces are jigsawed from ¼" plywood, or from solid wood. Plywood is less apt to split. Drill the holes a snug fit for the dowels. Fasten these in with glue. Place the frame on a flat surface with a weight on it until the glue sets.

Give both tray and stand a priming coat of flat ivory paint or enamel undercoat. Finish with two coats of ivory enamel.

The floral decorations add a finishing touch. Flowers are yellow, red, and blue, with dark-green stems and leaves. In place of the painted flowers, small decalcomania transfers might be used.—ELMA WALTNER.

## ELECTROPLATING WITH SILVER [*ELECTRICAL*]

Work to be silver plated, after first being plated with copper, should be treated in a "quicking" bath, which coats it with a mercury amalgam, otherwise the silver electrolyte will produce an unstable deposit.

**Quicking bath.** In 1 gal. water dissolve 1½ oz. mercurous nitrate. Add sufficient nitric acid to clear the solution. Dip the cleaned work only long enough to produce an even, bright coating of mercury. The electric current is not used. Rinse the work well before placing it in tne silver electrolyte.

**Silver electrolyte.** In 1 gal. water dissolve 6 oz. sodium cyanide (POISON). Add 3 oz. silver chloride and, when that has dissolved, 6 oz. sodium carbonate. Current of 5 volts may be used for the first minute of electroplating, but for the remainder it should be reduced to from 1 to 2 volts. Plating is kept uniform by agitating the electrolyte.

**Strike bath.** Articles of white metal, containing tin and lead, need not be copper plated. They should first be given an initial coating of silver in a strike bath, using the electric current. A suitable solution contains 8 oz. sodium cyanide (POISON) and ¾ oz. silver chloride, dissolved in 1 gal. water.

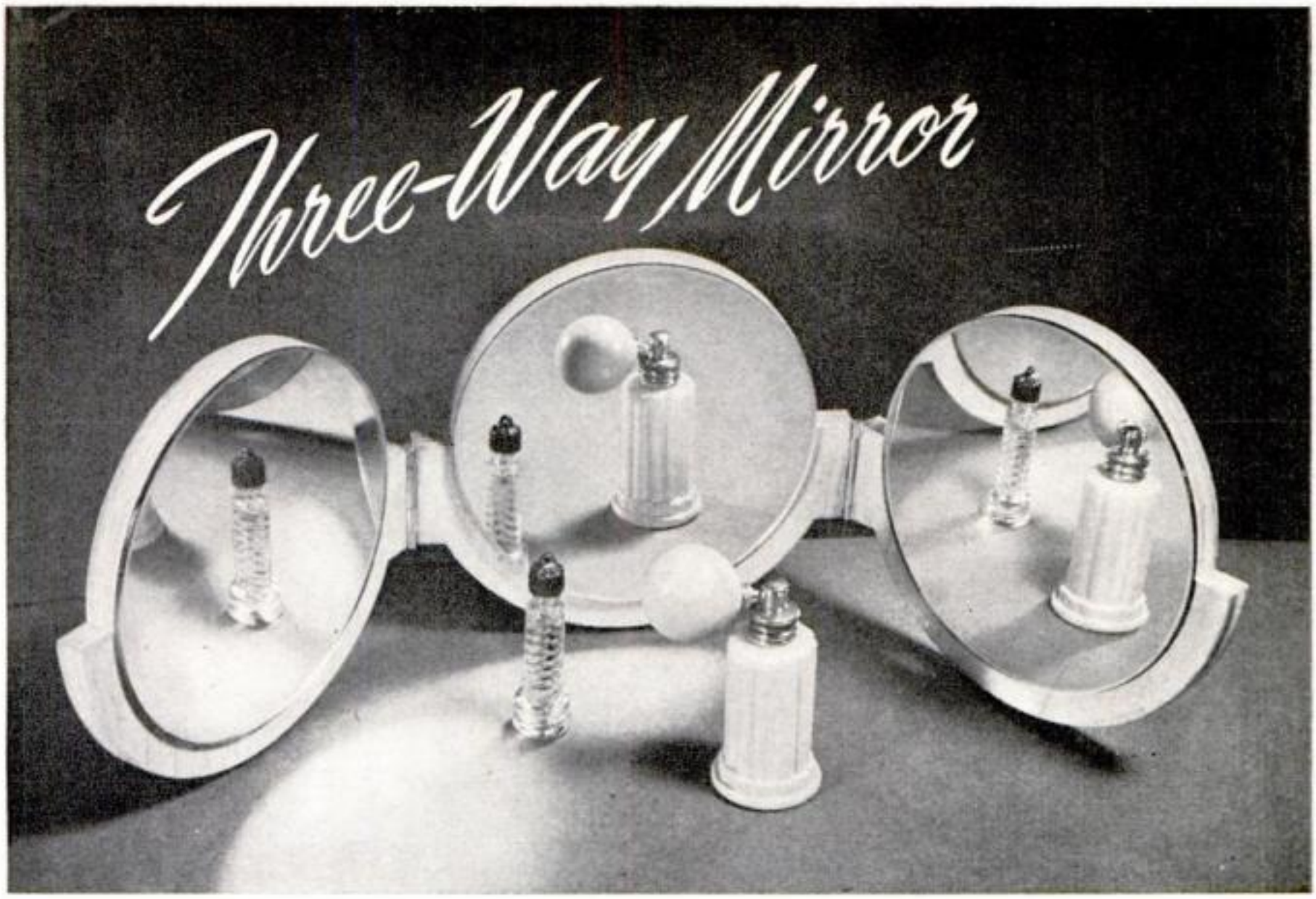
**Sectional plating.** To build up sections which receive the greatest wear, immerse only those sections for a part of the plating time. The work should be moved frequently to avoid unevenness.

**Bright plating.** A matte finish, desirable for special effects, will be obtained unless the solution is prepared for bright plating. To make a bright plating solution, add 10 drops of carbon disulphide to 3 oz. ordinary silver electrolyte. Shake well, and then add only a sufficient number of drops to the plating solution to secure the desired result.

After use, the electrolyte solution should be filtered and stored in a stoppered bottle as foreign matter in it will cause blisters.

Pure silver is best for anodes. On a small scale, sterling may be used, as the copper of this alloy will not easily transfer to the work. In time, however, it will cause the electrolyte to be loaded with accumulated copper. Anodes should be annealed to assure good solubility.

POPULAR SCIENCE MONTHLY SHOP DATA




# Make-Up Glass Shows the Face from Any Angle

## DESIGNED BY JUAN OLIVER

A TRIPLE mirror is ideal for correcting milady's hair-do or for locating that last bit of stubble in milord's chore of shaving. Here is one that you can easily make for yourself, provided you can do a neat sawing job on ½" plywood, and can use a screw driver and a paintbrush.

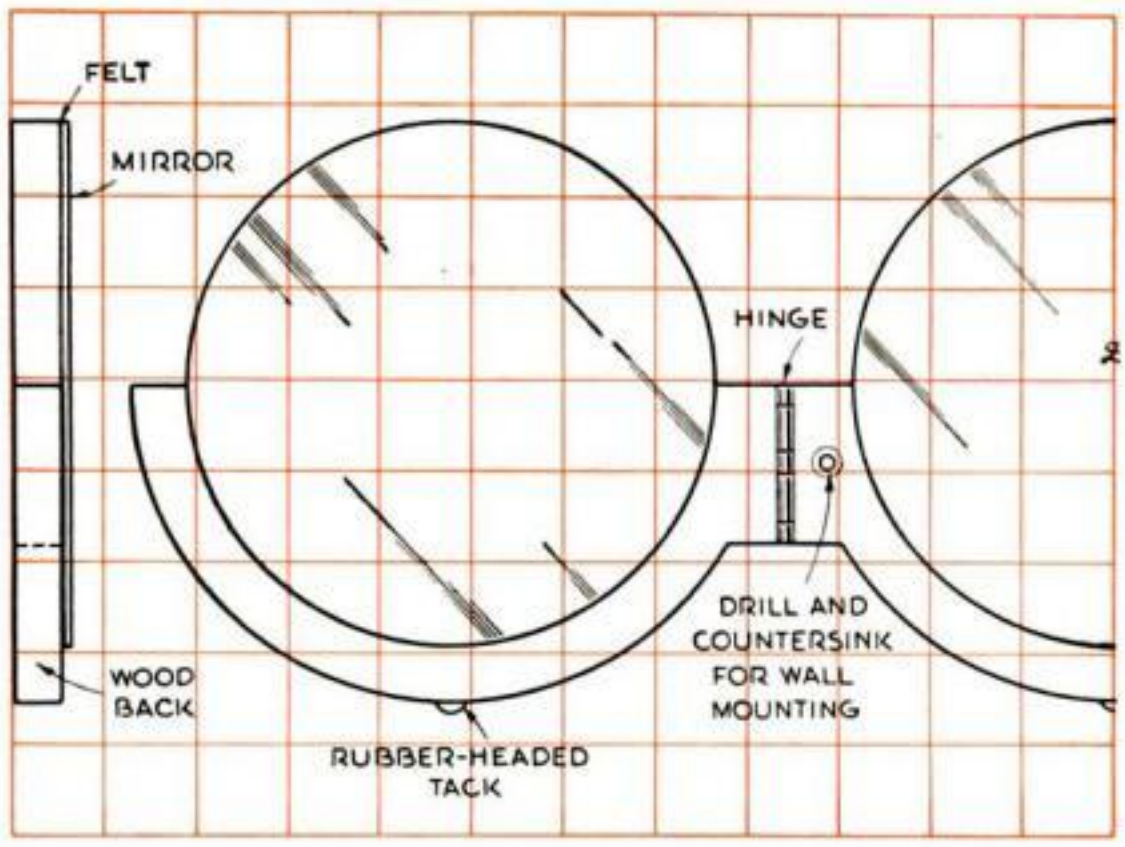
Circular mirrors, backed with felt, are sold in five-and-ten-cent stores. The three shown are 5¾" in diameter, which is about as small as is practicable for the purpose. The backs are cut from ½" plywood with a coping saw or on a jig saw. Cut outside the lines so as to leave a little stock for sanding the edges smooth.

Spread a coat of glue over the felt on the backs of the mirrors and also over the faces of the wood backings. When the glue is nearly dry, put the mirrors in place and leave weights on them overnight.

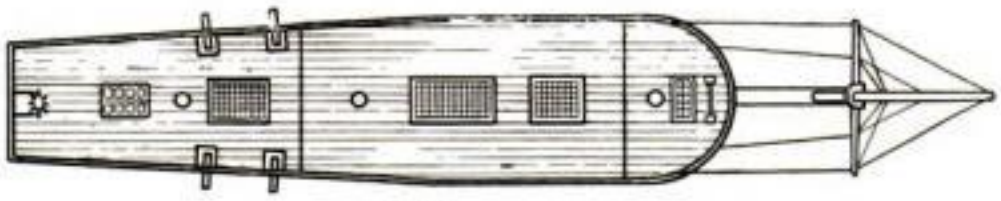
White-pine plywood was used in this case, and the frame was merely smoothed and lacquered. If you prefer an enamel finish, fir plywood will serve. A flat undercoat and one or two coats of enamel will cover it nicely.

The hinges are brass, 1¾" long, with ½" wide leaves. They may be either plain or plated. If the mirror is to be fastened on the wall, drill a hole through each ear of the middle member for a mounting screw. If it is to stand on a polished surface, drive a rubber-headed tack into the bottom edge of each section.

Where a two-color effect is desired, the edges may be finished in one color and the face surfaces in another.

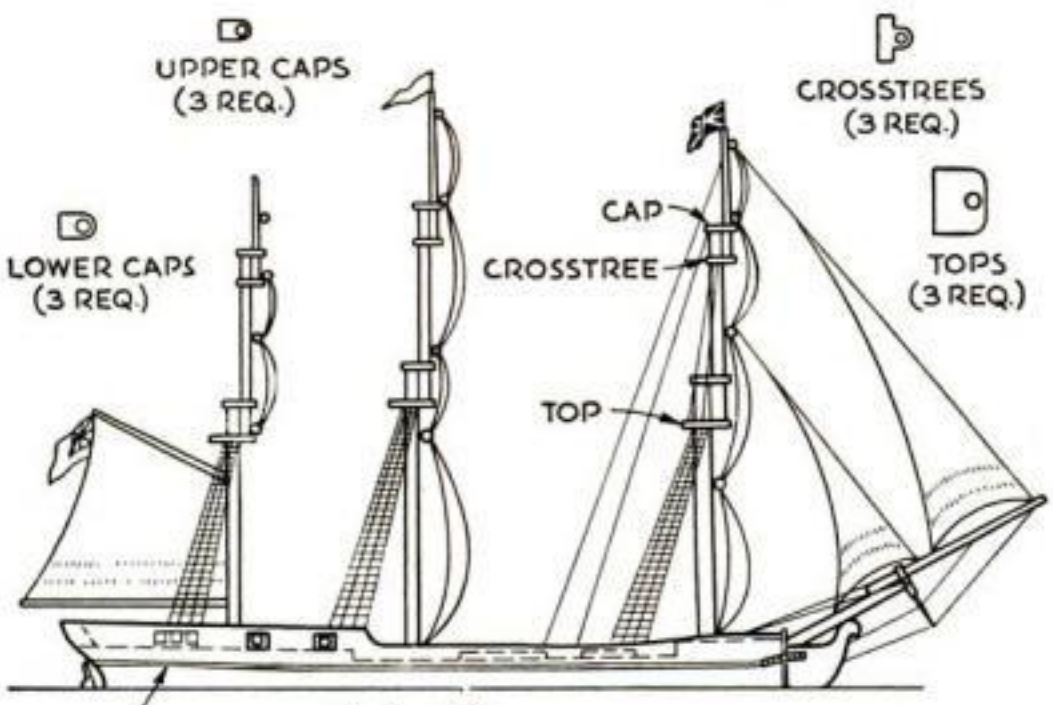


# Ship-in-Globe

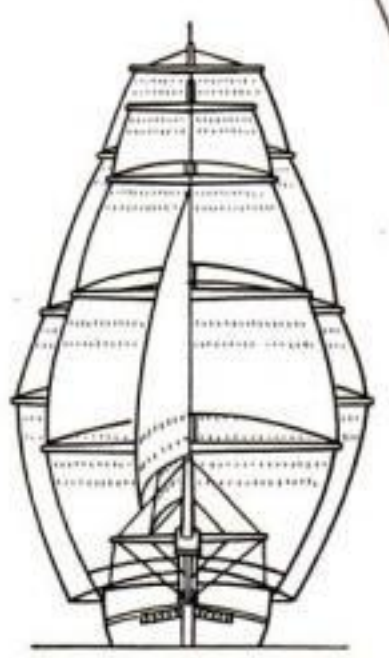


Plan

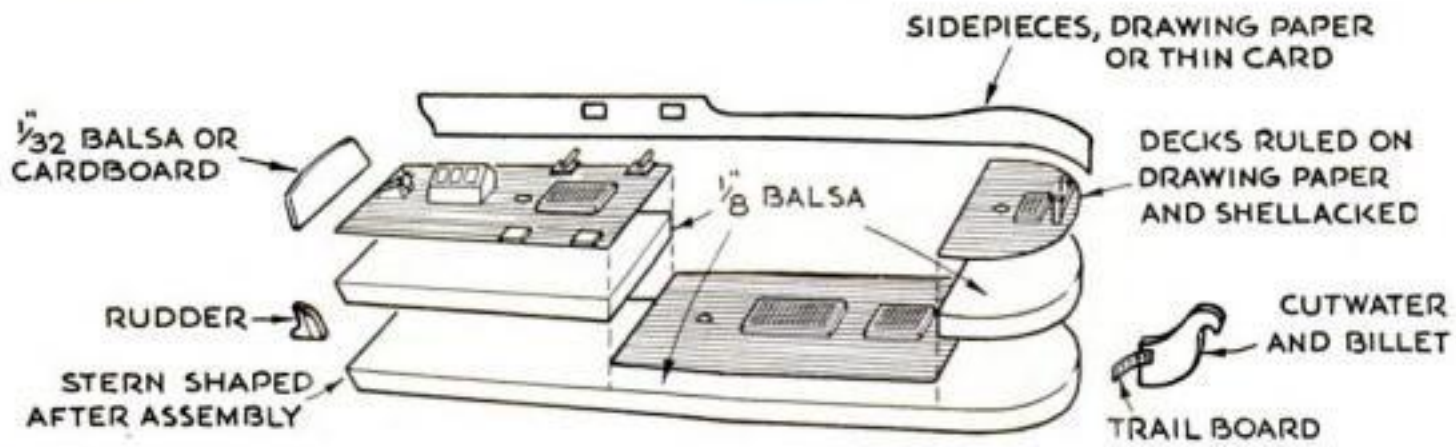
Stern




Side View

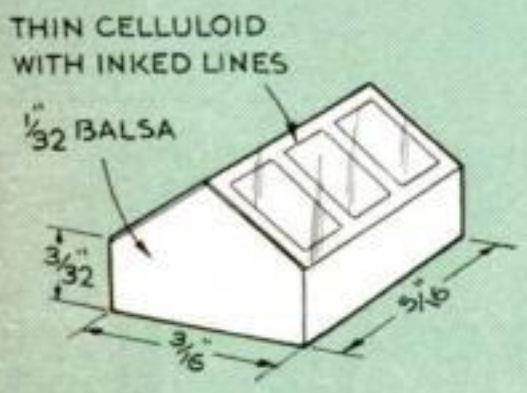


Bow

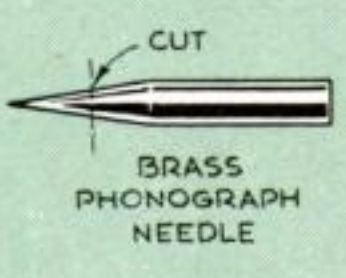



Hull Assembly

HULL AND YARDS, BLACK
MASTS, WHITE
TRIM STRIPS CUT FROM
GUMMED ENVELOPE FLAP

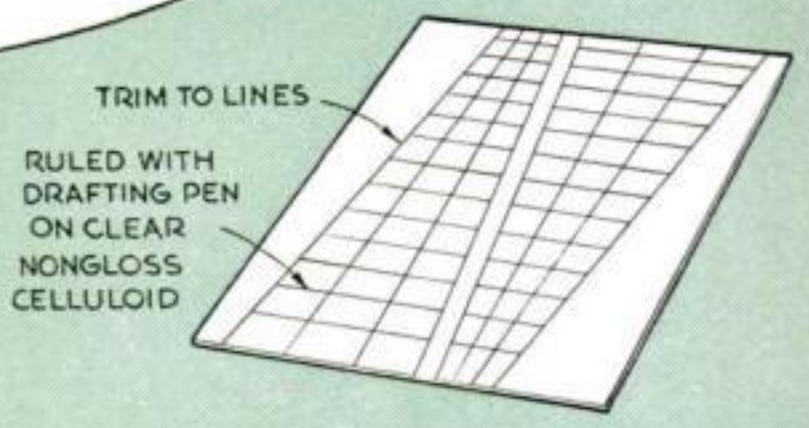



Cabin Skylight





Guns




Shrouds and Ratlines

HW 86

# Table Lamp

By JOHN J. GALLIVAN

A SHIP in a bottle is always fascinating, but put a tiny model of the storied *Bounty,* all sails set, into a well-proportioned glass globe with an electric socket at the top, and you have a nautical lamp that every lover of the sea will be proud to own.

The use of a wide-mouthed globe simplifies the work. That illustrated is 6″ in diameter; check the one selected, and build the ship to fit. Cover the bottom 1″ deep with plaster of Paris mixed with water containing enough bluing to give a "sea" color. Pour the plaster through a paper funnel to avoid splashing. After it has set, paint with blue, green, and a touch of white on the high spots.

The turned wooden base adds a craftsmanlike touch. Apply a dark stain, follow with shellac, and rub to a dull, satinlike finish. The center recess should fit the bottom of the globe, to which it is glued.

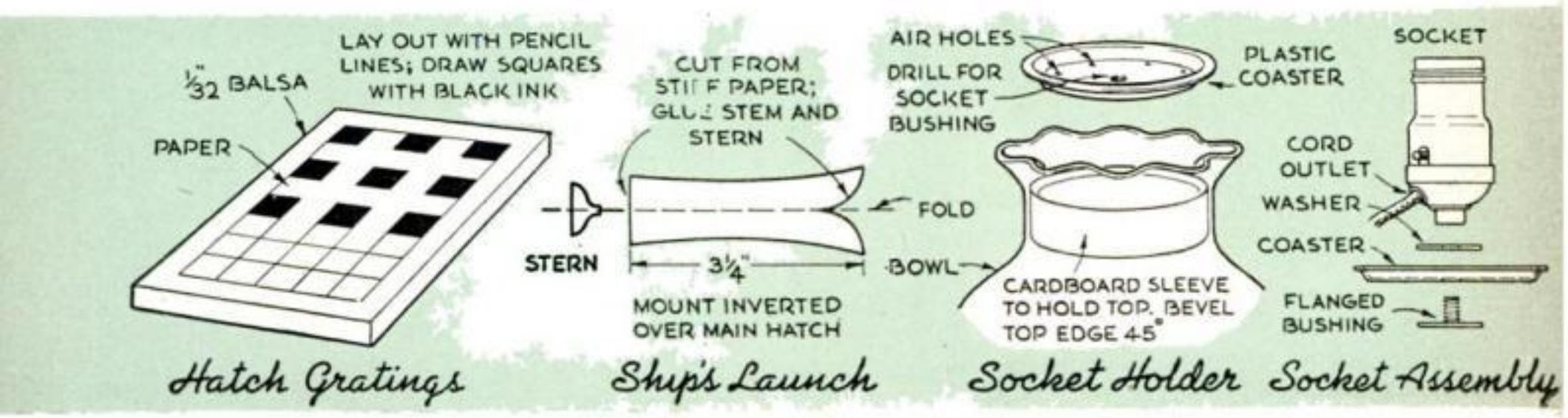
The ship model and its parts are shown exactly half size in the drawings. All dimensions can therefore be taken off with a pair of dividers or a small scale.

Build up the hull as shown, adding such details as guns, hatches, and skylights. Before gluing in the masts, assemble them with the yards. Cut the sails slightly longer than the distance between the yards to give a billowing effect. The shrouds can be made by ruling black ink lines on celluloid, as shown, but a more authentic effect is achieved by running thread across pins to form the ladderlike pattern and shellacking to bind and stiffen it.

Glue the foremast into the hull with its shrouds and stays. Add the inner jib and the flying jib after rolling them to appear filled with wind. The ship is then ready to be put into the globe.

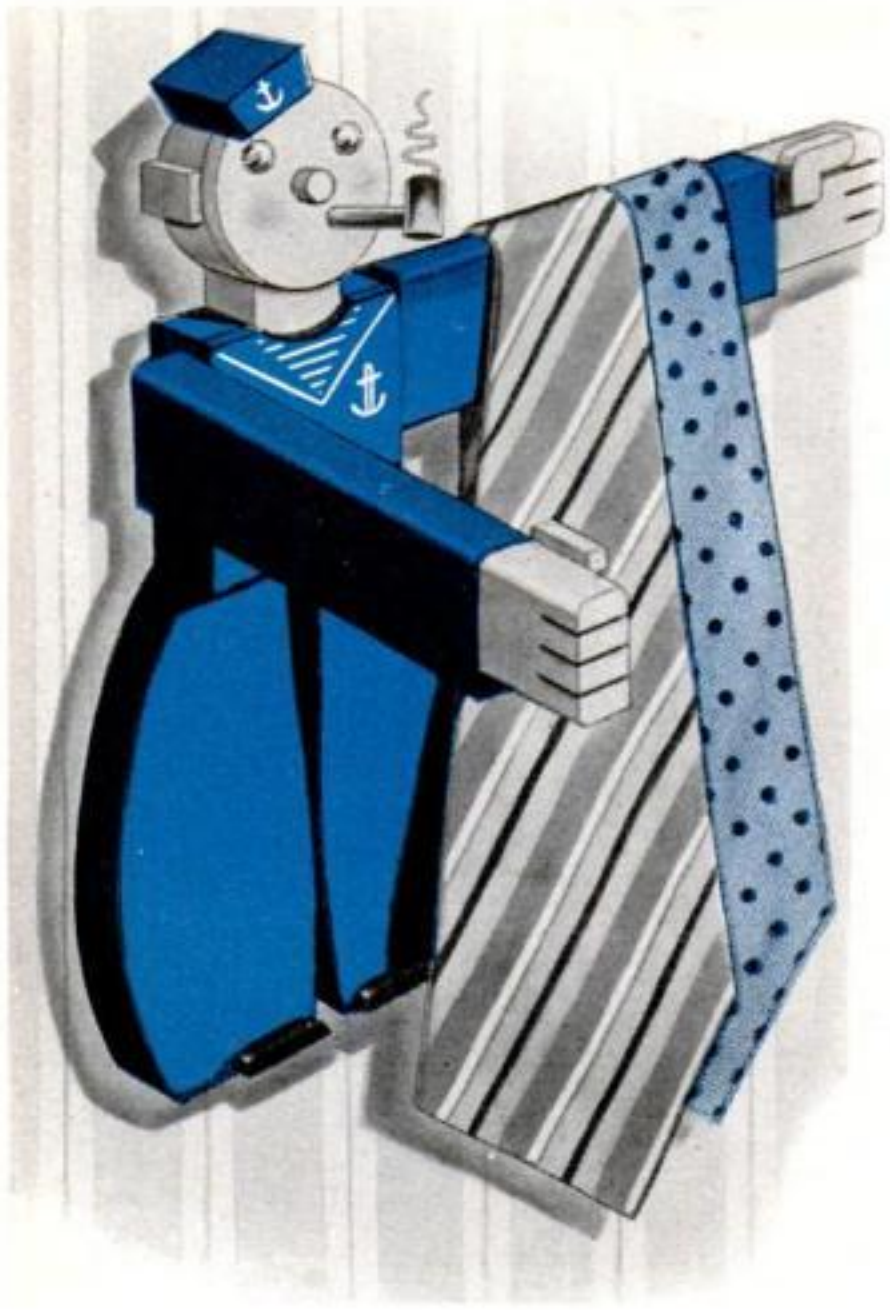
Apply quick-drying cement generously to the bottom of the hull. Lower it stern first into the globe as far as the foremast shrouds; then grasp the tip of the foremast, letting the stern swing back. This will permit the bowsprit to slip through. Lower the ship until it rests on the plaster "sea," and press with a pencil until the cement holds. Now take the mizzen, or aftermost mast, and attach the shrouds to the crosstrees. Put a drop of model-airplane cement on the foot of the mast and the bottom edge of each set of shrouds and insert the assembly quickly into its place on the hull, using tweezers. With a pencil, push the shrouds in against the hull. Hold the mast a few seconds to make certain it does not lean. Fit the mainmast in the same way.

A cardboard sleeve need be cemented in only if the neck of the globe flares outward. Cut one edge on a bevel to match that of the transparent plastic coaster that forms the top plate. Trim or sand the coaster if necessary. A turned wooden sleeve or plate can be substituted, if preferred. Assemble the coaster and socket with a washer and a flanged bushing, and cement it to the sleeve. Use a side-outlet socket cap as shown.




HW 87

# AYE, AYE, SIR— I'LL HOLD YOUR TIES!



By JUAN OLIVER

OUT of an ordinary pine board comes this amusing tie holder. A few pieces of ¼" stock are glued on to secure three-dimensional relief. The arms swing forward to make it easy to select or replace ties.

Saw the head, ears, cap, body, and legs from one piece of ¾" stock. The face, jacket, and feet are cut from ¼" stock and glued and tacked on. The face piece includes the cap. To it is attached still another piece that forms the cap projection. Both pipe and nose are bits of dowel inserted in holes. The smoke is a twisted piece of wire.

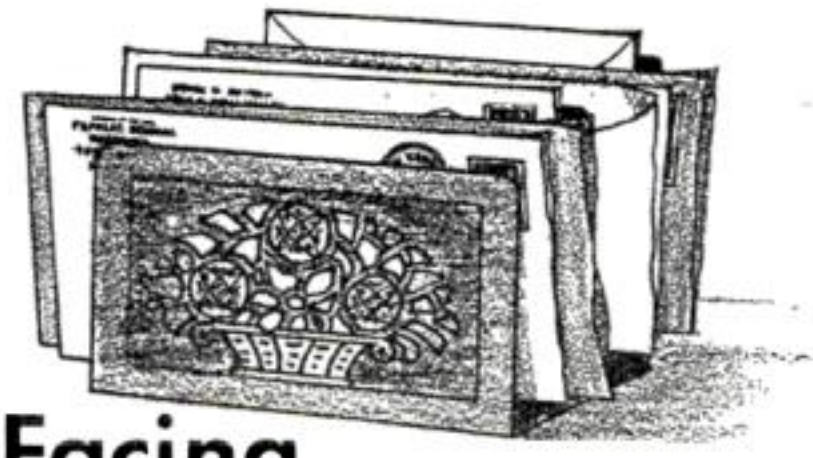
Cut the arms from ¾" stock, indicating fingers with straight saw cuts. The thumbs are ¼" thick and glued on.

Royal blue for brightness—or navy blue if you must be a precisionist—is the main color, with flesh of a salmon pink, pipe and stem touched with black, and jacket braid suggested by white lines. Use gilt tacks for eyes. A single screw through a hole behind the nose fastens the figure to the wall.




HW 88

# Letter Rack



# with Tooled-Leather Facing

By JOHN DEAN

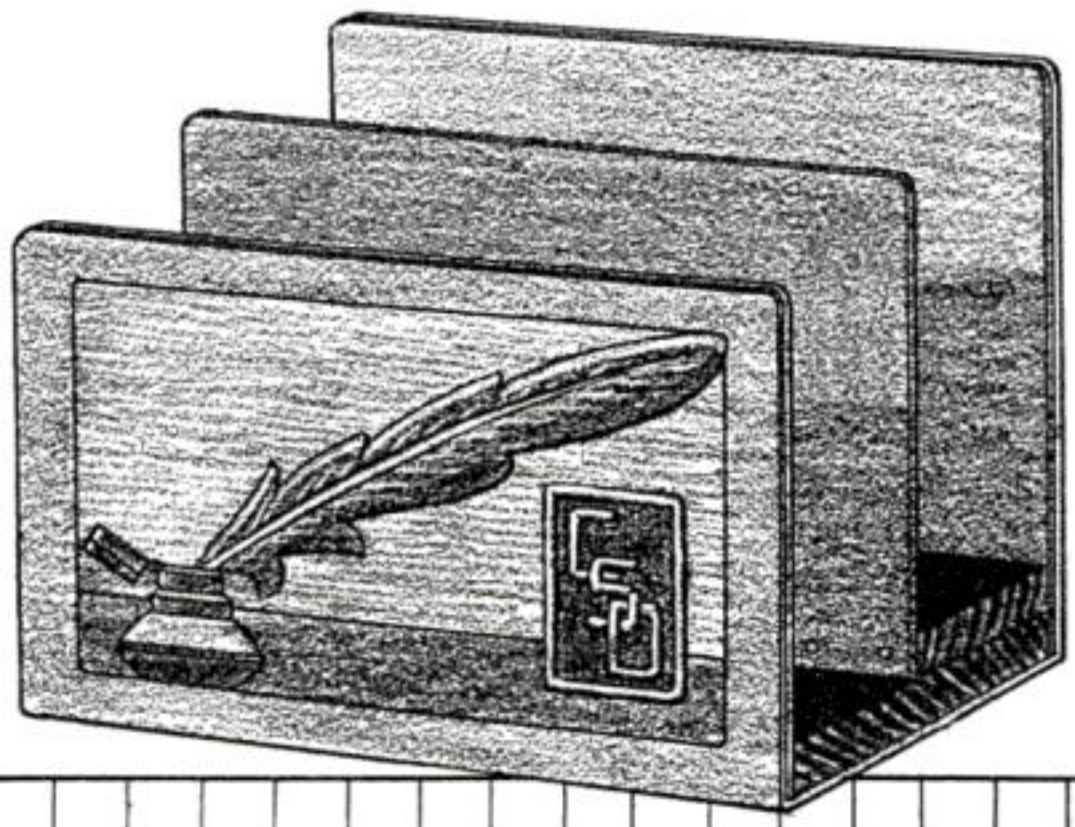
PRACTICAL on the home or office desk for holding stationery, this tooled-leather rack may be made in two sizes—with a front panel 6″ long and 3½″ high for ordinary envelopes, or 5″ by 3¼″ for small envelopes or filing cards. The middle partition is the same size as the front panel, and the back ¾″ higher. These panels may be of thin wood, bookbinder's board, or heavy fiber board. The base consists of two pieces of ⅜″ wood, one 3″ wide and the other 1½″, and both as long as the upright panels.

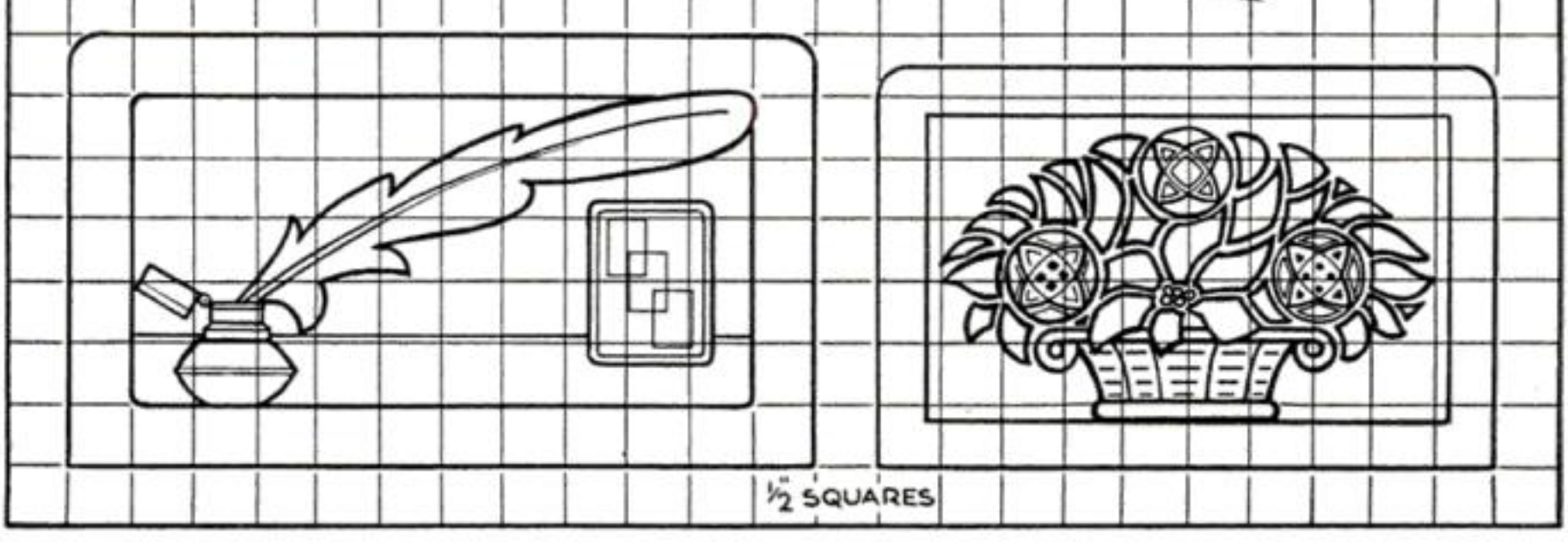
Sand and stain the exposed surfaces, and assemble with glue and nails. Then wax the top and ends. If the uprights are wood, wax their exposed surfaces also.

**Fold a piece of paper** around the front, bottom, and back for a pattern; then draw the design on what is to be the front panel. Cut a piece of tooling calf or cowhide about 6″ by 11″ to allow for final trimming. Wet the leather thoroughly and dry it to the tooling stage. Lay the pattern over the moist leather, trace the design with a hard pencil, and tool, stamp, and stain it. Let the leather dry naturally. Trim the top edge of the front panel and mark on the reverse side where it is to fit the frame.

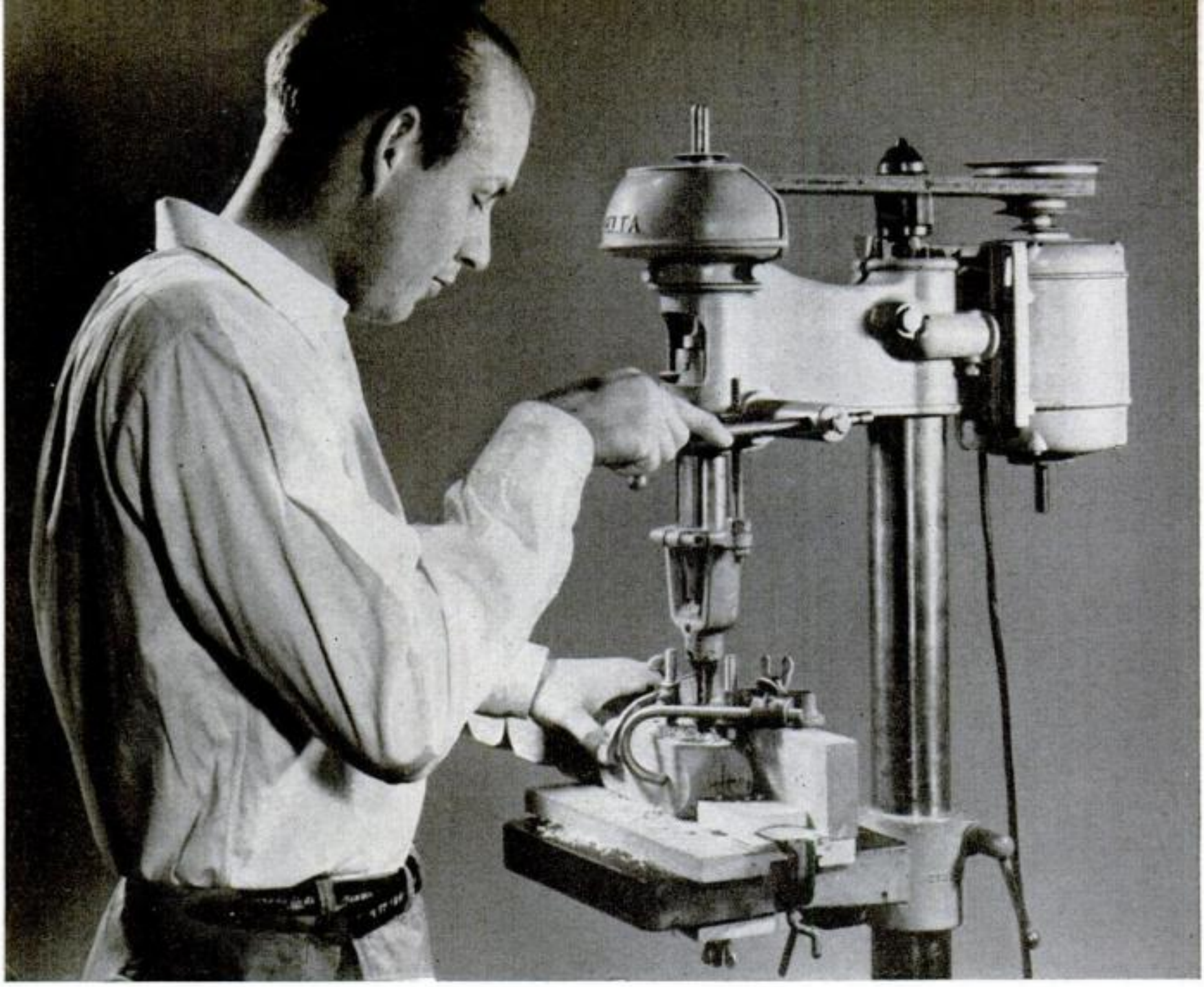
Cover the outside of the frame and the back of the leather with a thin coat of rubber cement, and let dry until the "shine" has disappeared. Lay the front of the frame in place on the leather and press down firmly; next tip it backward so the bottom will adhere; then repeat for the back. Pressure may be applied at front and back for an hour or two before trimming away the surplus leather with a sharp knife. Cut toward the frame to avoid pulling the leather off. Stain the cut edges. Polish the surface with two parts liquid floor wax to one of water.

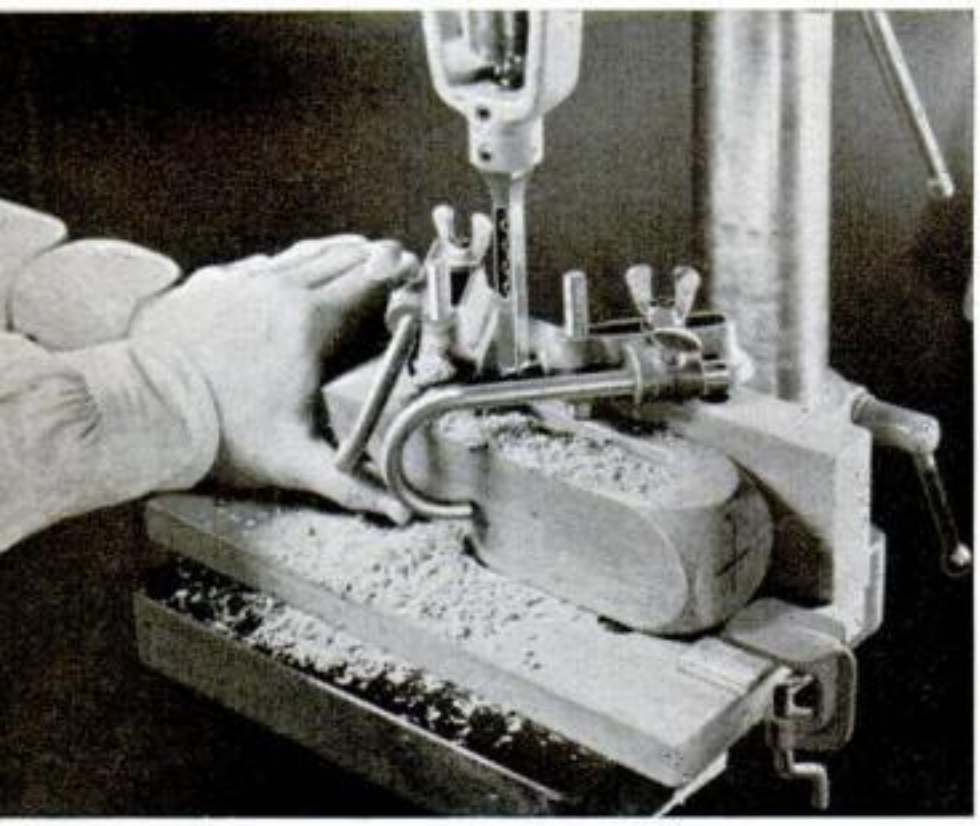
The edges may be decorated, if desired, with small nails, pins, or spots, or they may be laced, in which case drill the wood beforehand and the leather after assembly






HW 89





A drill press with mortising accessories attached. Here a removable block locates the start of a mortise. At left, the end is located by the fixed stop

# Mortising and Shaping ON THE Drill Press

**By EDWIN M. LOVE**

NO SMALL degree of skill is required to cut a mortise accurately by hand. If the joint is to remain tight, the mortise and tenon must be made a close fit. The parts must also be properly aligned if the finished piece is not to be askew. However, when a drill press is put to the task, most of the labor and all the guesswork are taken out of the job.

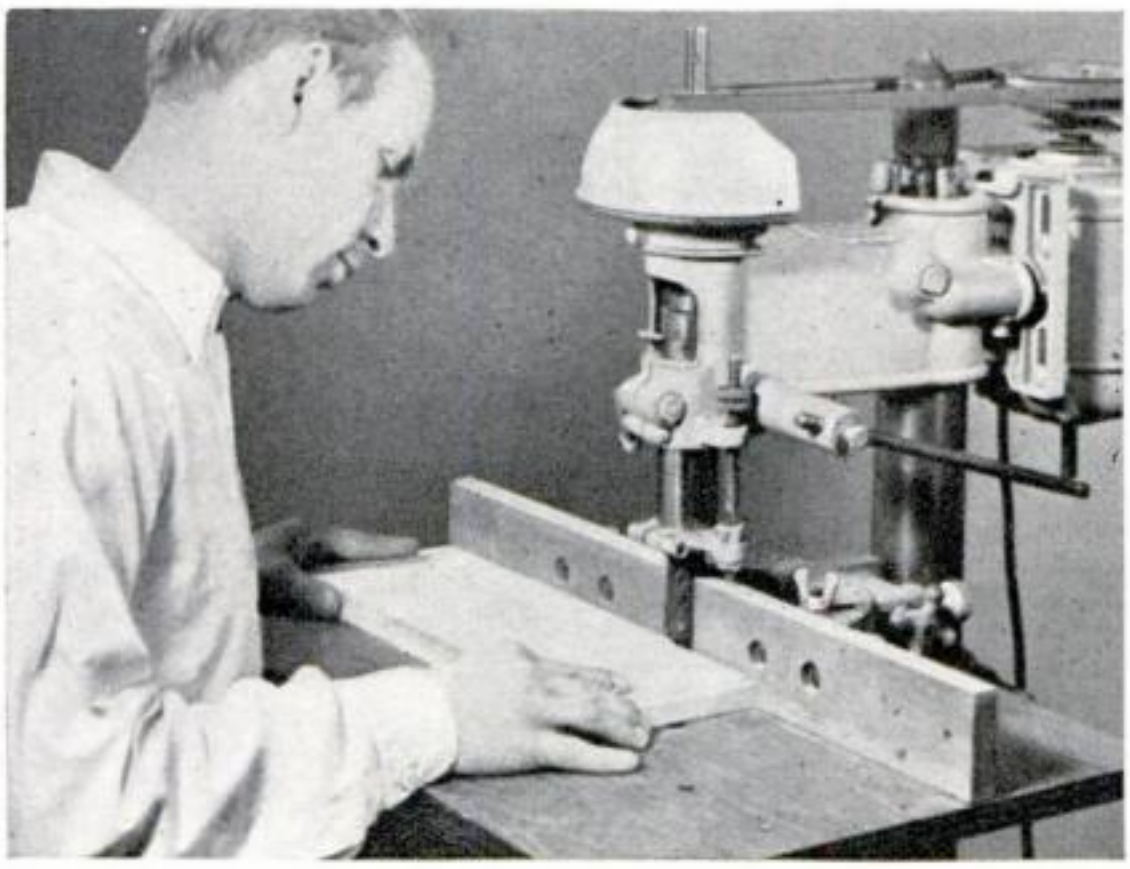
Another field of usefulness to which this versatile machine can be adapted is that of making moldings. Practically all the operations possible on a shaper can be done on the drill press, but the cuts must be somewhat lighter. Although ordinarily only the simplest moldings are attempted by hand, the press will make light moldings of any kind and intricacy.

*What accessories are used in mortising?* The cutting tool is a square hollow chisel,

usually held in a special clamp on the quill (Fig. 1). Inside this whirls a bit, driven by the chuck. It bores a round hole, which is automatically trimmed square by the chisel.

Insert the chisel in the holder as far as the shoulder will permit. Adjust the bit so that its spurs clear all the cutting edges of the chisel by about 1/16", as shown in Fig. 1. Lock it tightly in the chuck so that it cannot creep up when pressure is applied. Heating and burning of the bit may result if there is insufficient clearance at the cutting edges, or if the bit is bent so that it binds in the chisel.

*What is the setup for mortising table legs?* Two main points must be considered —how far the mortise is to be from the face, and how far from the upper end it is to start. The spacing from the face is gauged by a fence bolted to the drill-press



Cutting an edge rabbet in a drill press with a shaper cutter. The same setup would be suitable for making straight moldings

Single mortises can be marked in pencil. Diagram at right below shows use of blocks as in the photos on the facing page

Sufficient clearance between the bit and the edges of a mortising chisel is important. Too little results in friction, with heating or even burning of the chisel bit

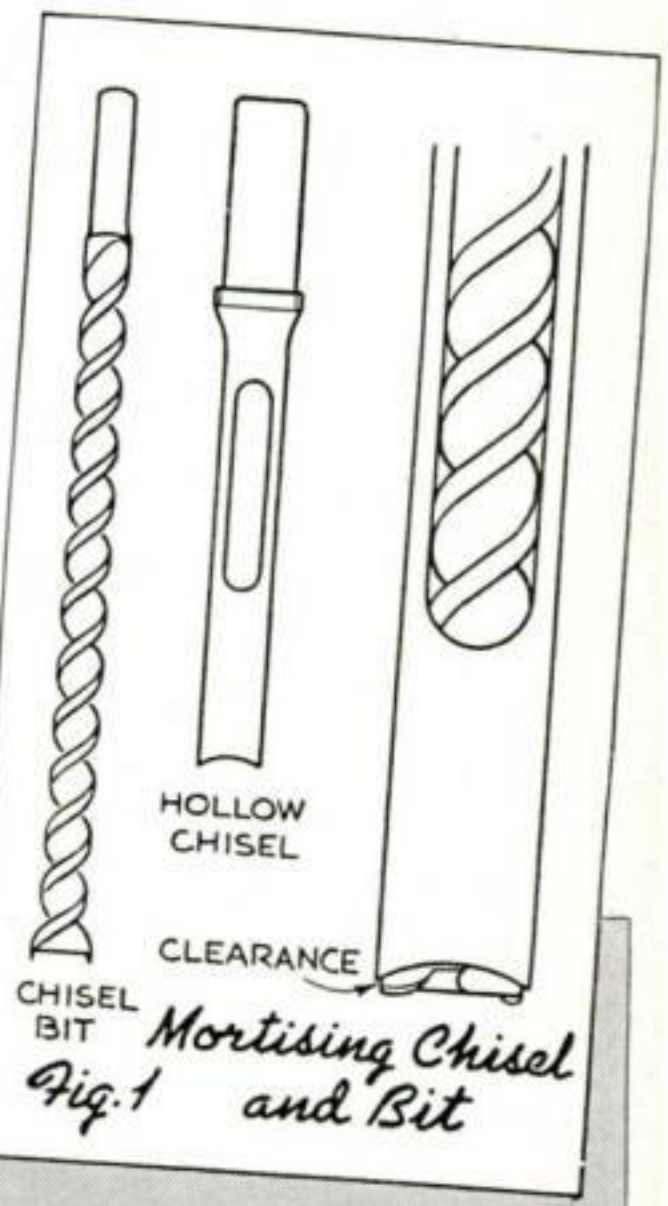
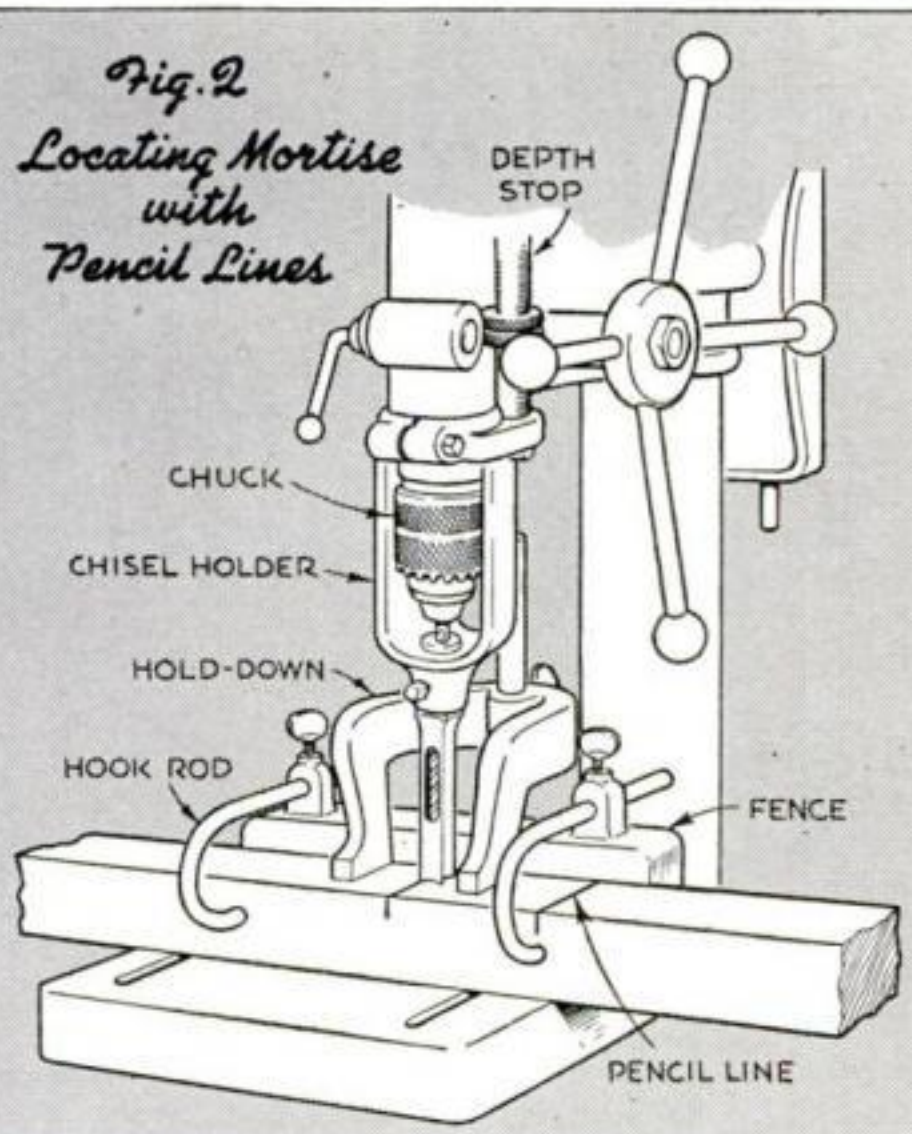



Fig. 1 Mortising Chisel and Bit

Fig. 2 Locating Mortise with Pencil Lines



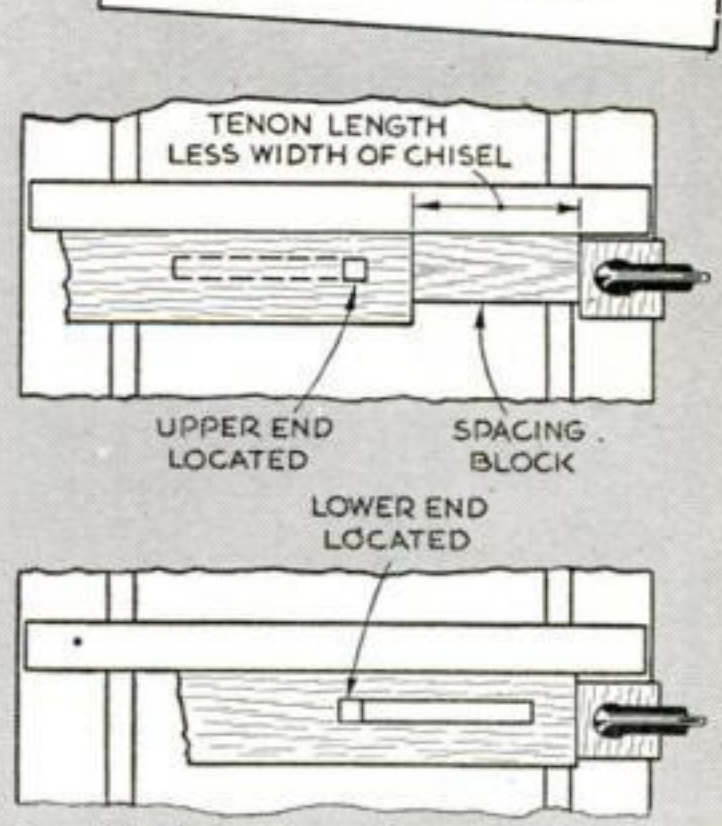




Fig. 3-Locating Single Mortises

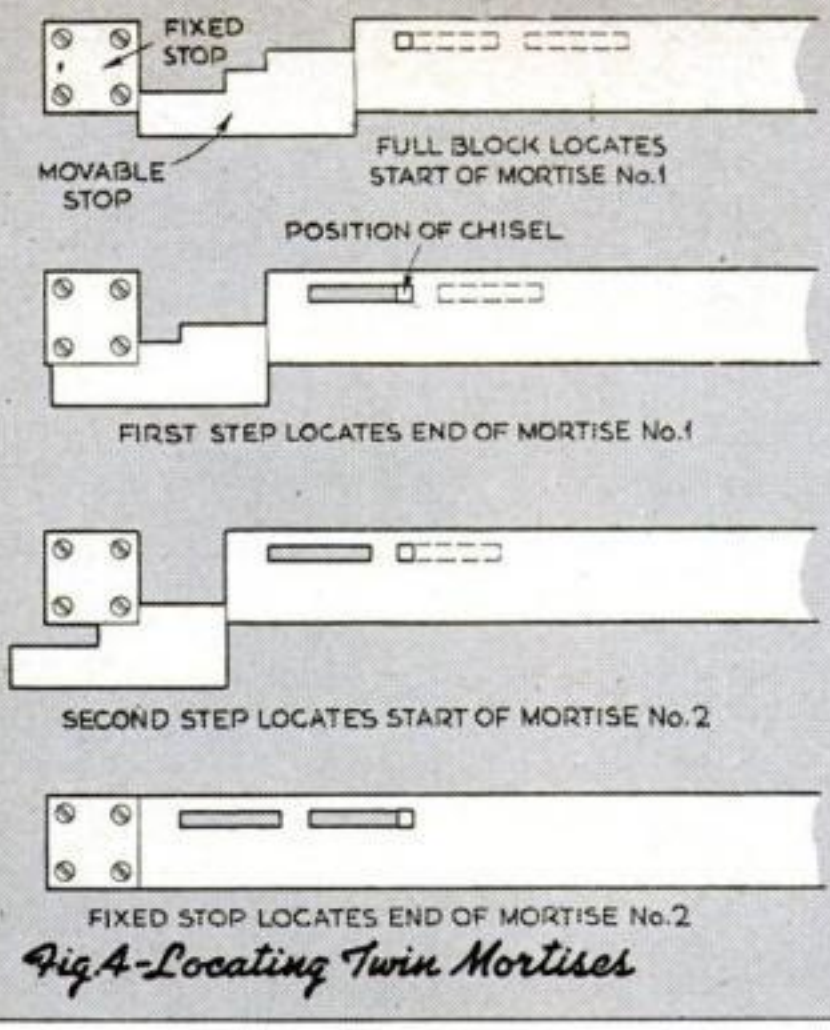



*Fig.4-Locating Twin Mortises*

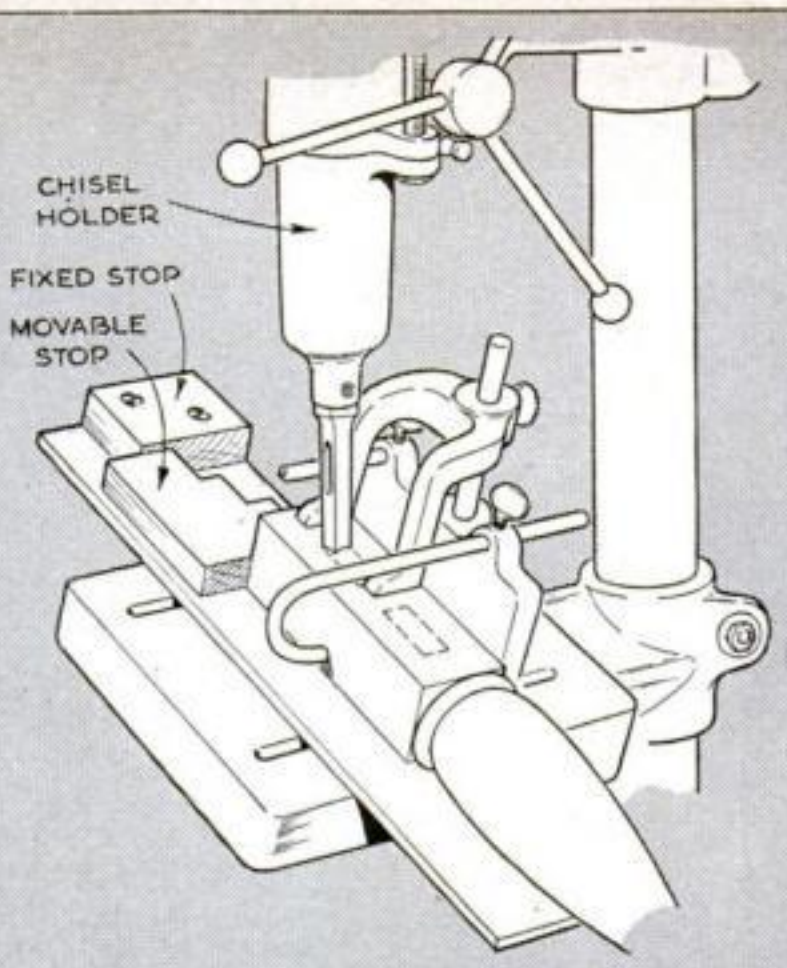


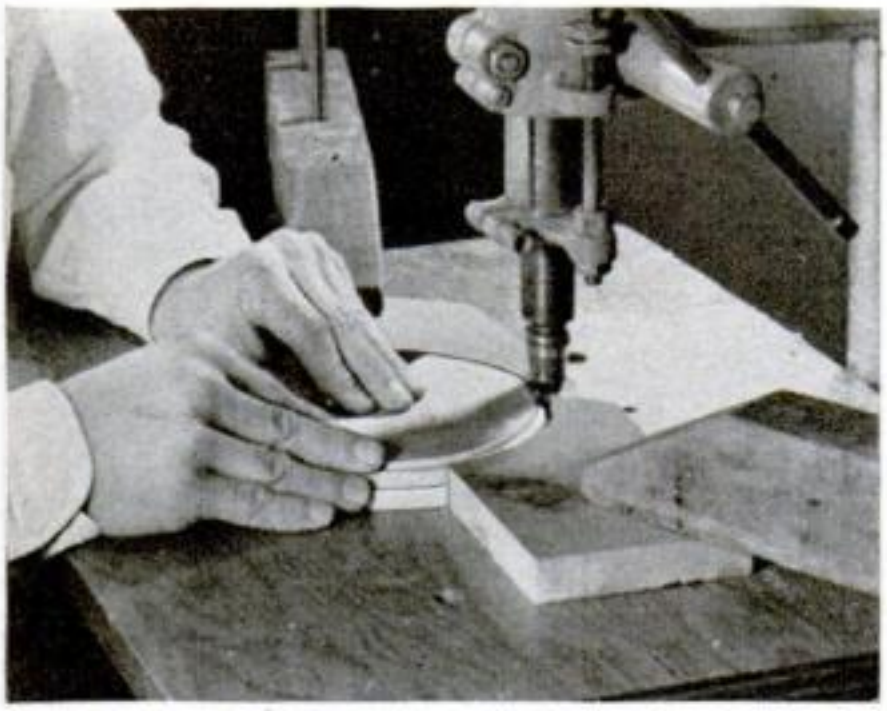

*Fig.5 – Mortising Splay Leg*

**Twin mortises are located with a stepped block. For mortises in splay legs, tilt the table as shown**

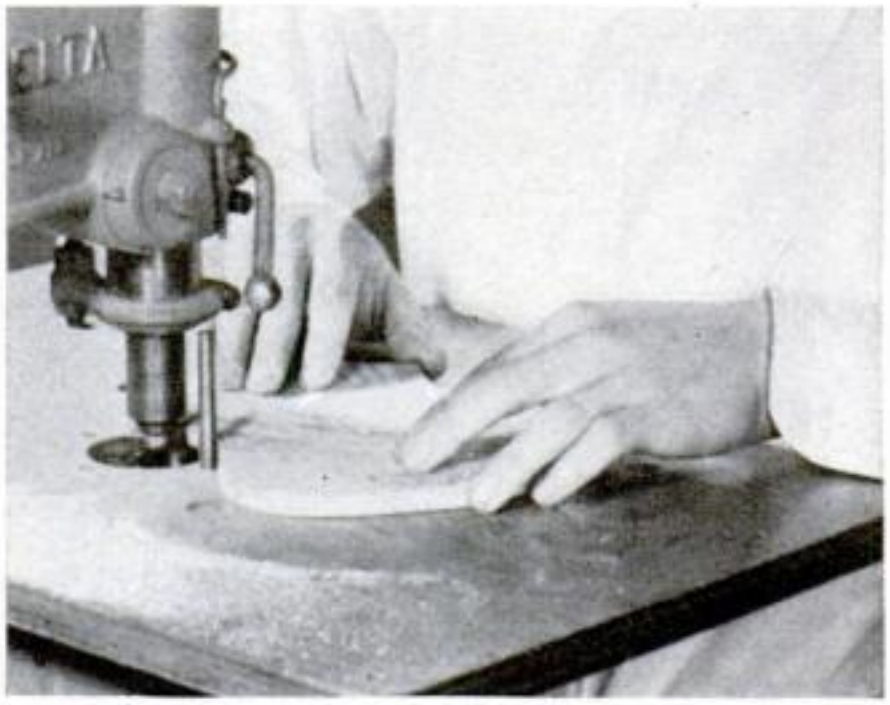
table. This fence must be square with the sides of the chisel, else the mortise will have stepped or staggered sides instead of straight ones. Pencil lines may be used to indicate the start and end of the mortise, as in Fig. 2, but where several identical legs must be mortised it is advisable to use stop blocks for automatic spacing (Fig. 3).

Spindle speeds as high as 3,600 r.p.m. are used in commercial production work, but the writer has found 2,000 r.p.m. a very satisfactory speed for mortising on a high-grade bench drill press. With the work in place, set the stop nuts to the desired depth and gradually feed the bit down as far as it will go. Keep the chip slot clear as you work. When the first cut has been made, lift out the bit, move the work along the fence a little less than the width of the chisel so that the second cut will overlap the first, and repeat as often as necessary to cut the mortise to the required length. When mortises are to be wider than the chisel, a second series of cuts is made overlapping the first.

*Can jigs be used for duplicate work?* Yes. They can easily be made up to suit the job on hand. Figure 4 shows how a jig consisting of a fixed and a movable stop block is used to space twin mortises. The full length of the stepped block is used to locate the start of the first mortise, and



Shaping on circular work is done against a fence sawed to the same radius and notched to receive the cutter. A V-shaped fence could also be used



Freehand shaping is started against a stop pin. Pivot the work into the cutter, then feed against the collar directly. Never shape the entire edge

Fig. 6 – Typical Shaper Cutters

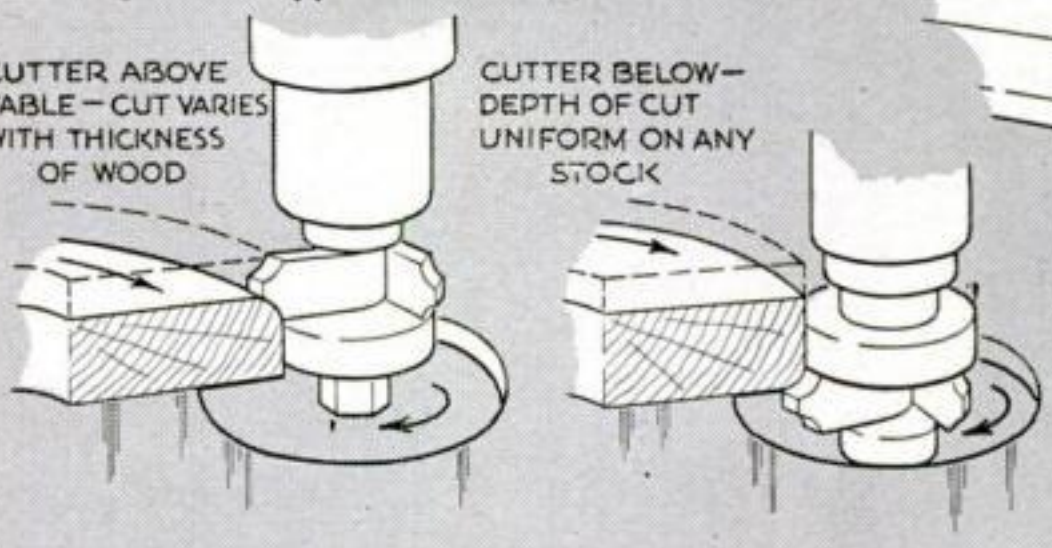



Fig. 7 – Shaping Top and Bottom Edges

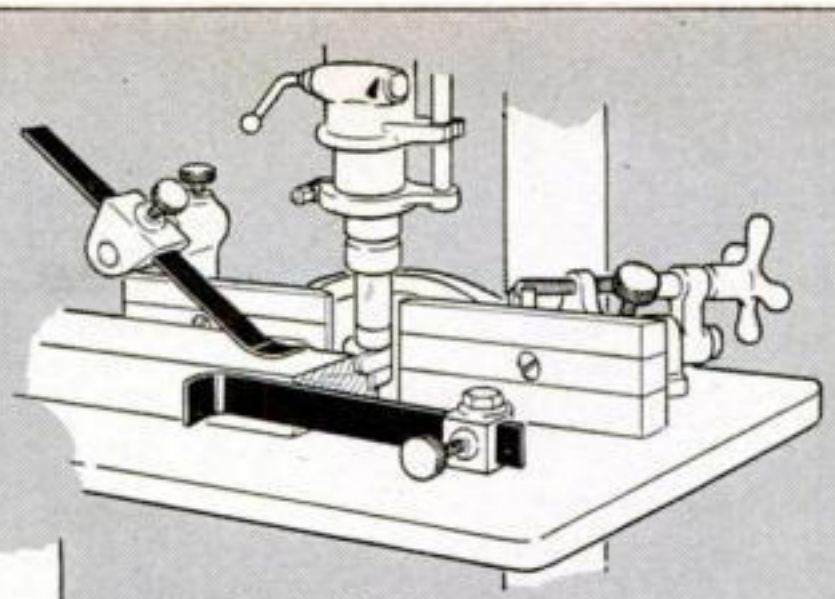


Fig. 8 – Using Spring Hold-Downs and Fence

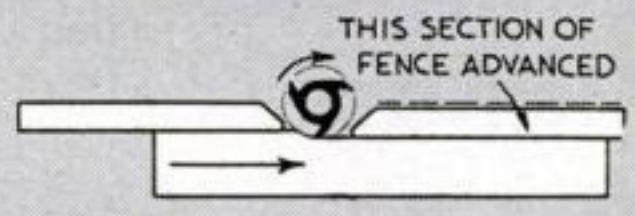



Fig. 9 – Jointing Edge of Board

Cutters and how they work. Below, inside and pattern shaping

the fixed stop alone gauges the end of the second mortise.

*How are mortises paired on the sides?* Set the stop for mortising one side, and do the work on all the legs on that side. Then reset the stop to mortise the other sides. The two setups are all that are needed for making any number of identical legs.

*What method is used to mortise sloping or splayed legs?* Tilt the table to the required angle (Fig. 5), set the hold-down and stops, and proceed as before. If the mortise is to slant crosswise to the length of the leg, put a wedge-shaped strip of wood between the fence and the work.

*How is the drill press used for shaping?* The basic requirement is high spindle speed —5,000 r.p.m. or more. For some types of work, the head can advantageously be turned upside down. The work must always be fed *against* the rotation of the spindle.

*What cutters can be used for making moldings?* Small three-bladed ones are usually used, and always at the highest speeds obtainable (Fig. 6). Never use larger cutters than those specified for the machine, as poor work or even breakage may result. Many cutters are designed to cut different profiles with the top and bottom edges, and as the drill press turns in only one direction, this requires that some moldings be cut on the underside of the work, and some on the upper edge. When the cutter is used on the underside, it is less dangerous to the operator, and the depth of cut remains the same on any number of pieces, since the face of the work slides on

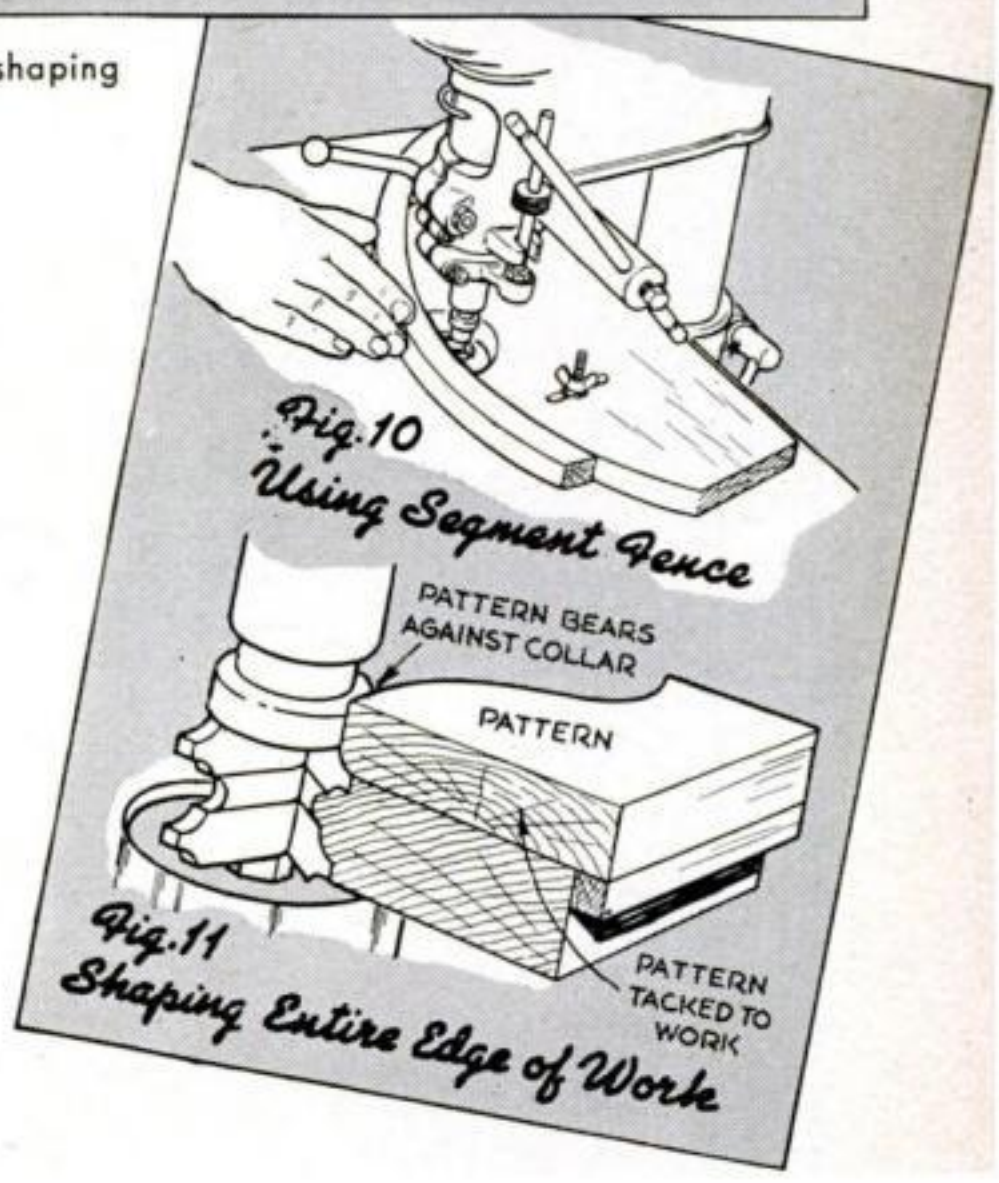



Fig. 10 Using Segment Fence

Fig. 11 Shaping Entire Edge of Work

the table. When used above, the cutter will cut deeper on thick stock than on thinner, and must be reset if identical moldings are to be produced on pieces of different thickness. Figure 7 illustrates this clearly.

*How are straight moldings made?* Use a fence, which may be a straight piece of wood cut out at the center to provide room for the cutter, or one obtained from the manufacturer, such as shown in Fig. 8. Mount the cutter so that it will cut in the

proper direction, and for maximum rigidity raise the table so that most of the quill may remain well in the head. Make test cuts on a piece of scrap. When all is correct, slide the work along the fence against the rotation of the cutter. For long pieces, and especially where stops are needed, an auxiliary plywood table is necessary. This may be a thin piece clamped under the fence, or a thicker piece clamped directly to the drill-press table.

When the entire edge of the work is cut away, as in jointing, advance the "following" section of the fence to support the front end as it comes from the cutter (Fig. 9). The same adjustment is useful in making some moldings.

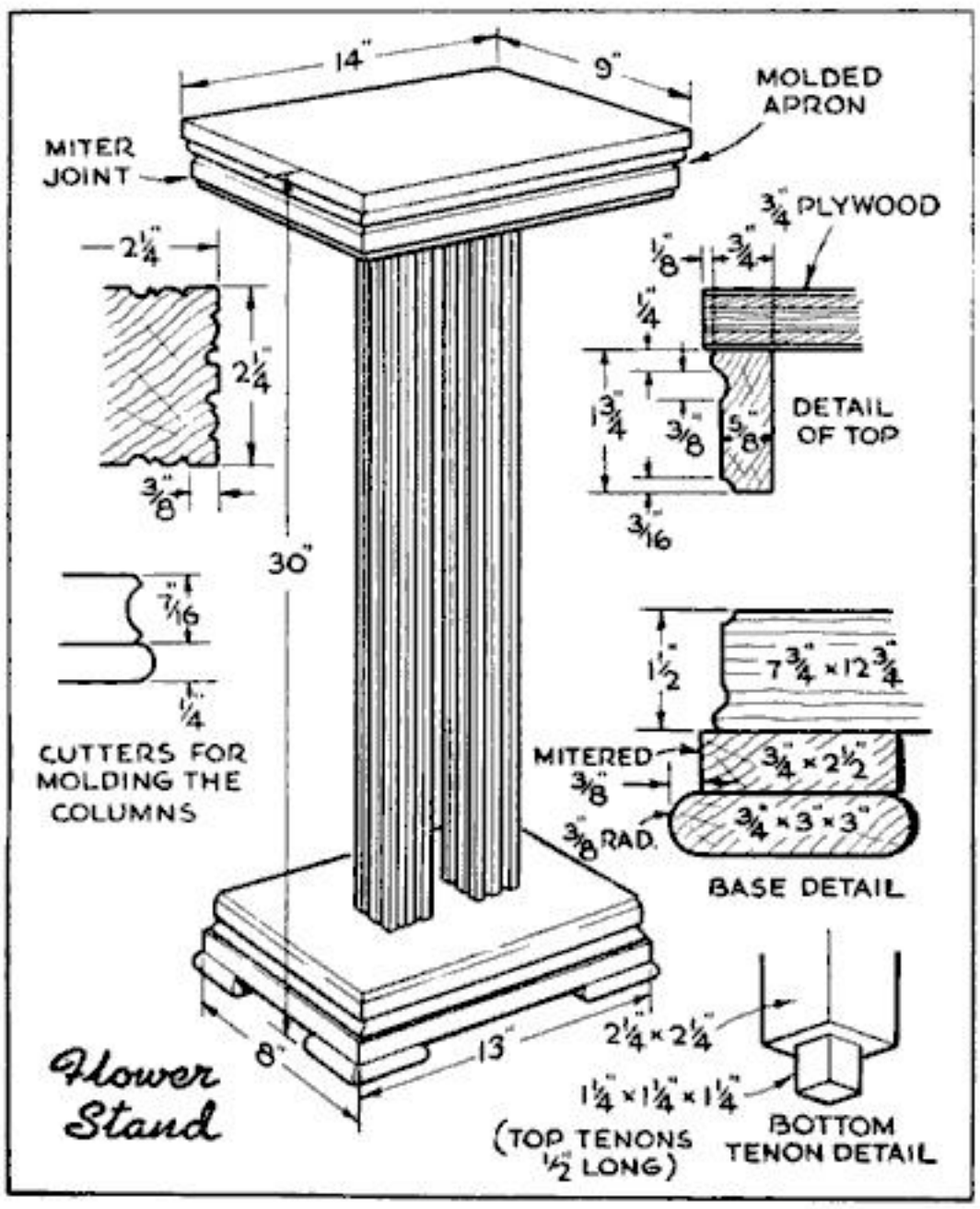
*How is circular work handled?* It can be done freehand, or, much better, by sliding it in a fence cut to fit, as shown in one of the accompanying photographs. For inside curves, use a convex fence notched to inclose the cutter (Fig. 10).

*Is irregular shaping possible with the drill press?* Yes. This is done freehand. The depth of cut is governed by a metal collar clamped under or above the cutter, and the height of the cut on the work is determined by raising or lowering the quill. For starting a cut, insert a pin in the table on the side from which the work is to be fed, and rest the piece against it, as shown in one of the photographs. Pivot the edge slowly into the cutter, and when the molding is started, swing away from the pin and follow against the collar. Never use a cutter that shapes the entire edge, as this would leave no guiding surface. The cutter would dig in, spoiling the work and perhaps injuring the operator.

*What is pattern shaping?* This is useful where duplication is required, or if the entire edge is to be molded. Cut a pattern from hard plywood and tack it to the top or bottom of the work. Guide the edge of the pattern against the collar (Fig. 11).

*How is sanding done on the drill press?* Some presses take sanding drums with shanks to be held in the chuck, while others use those with tapered shanks. Renewable sandpaper or emery-cloth sleeves are available for wood, plastics, and metals. They are generally used with an auxiliary table having a hole inside which the end of the drum may turn freely. If the drill press has a foot feed, this can be brought into play to move the drum across the work vertically and prevent scoring. An excellent tool for sanding small curves is a ¼" machine file turned at highest speed.

## Double-Column Fern Stand Gives Practice in Making Moldings

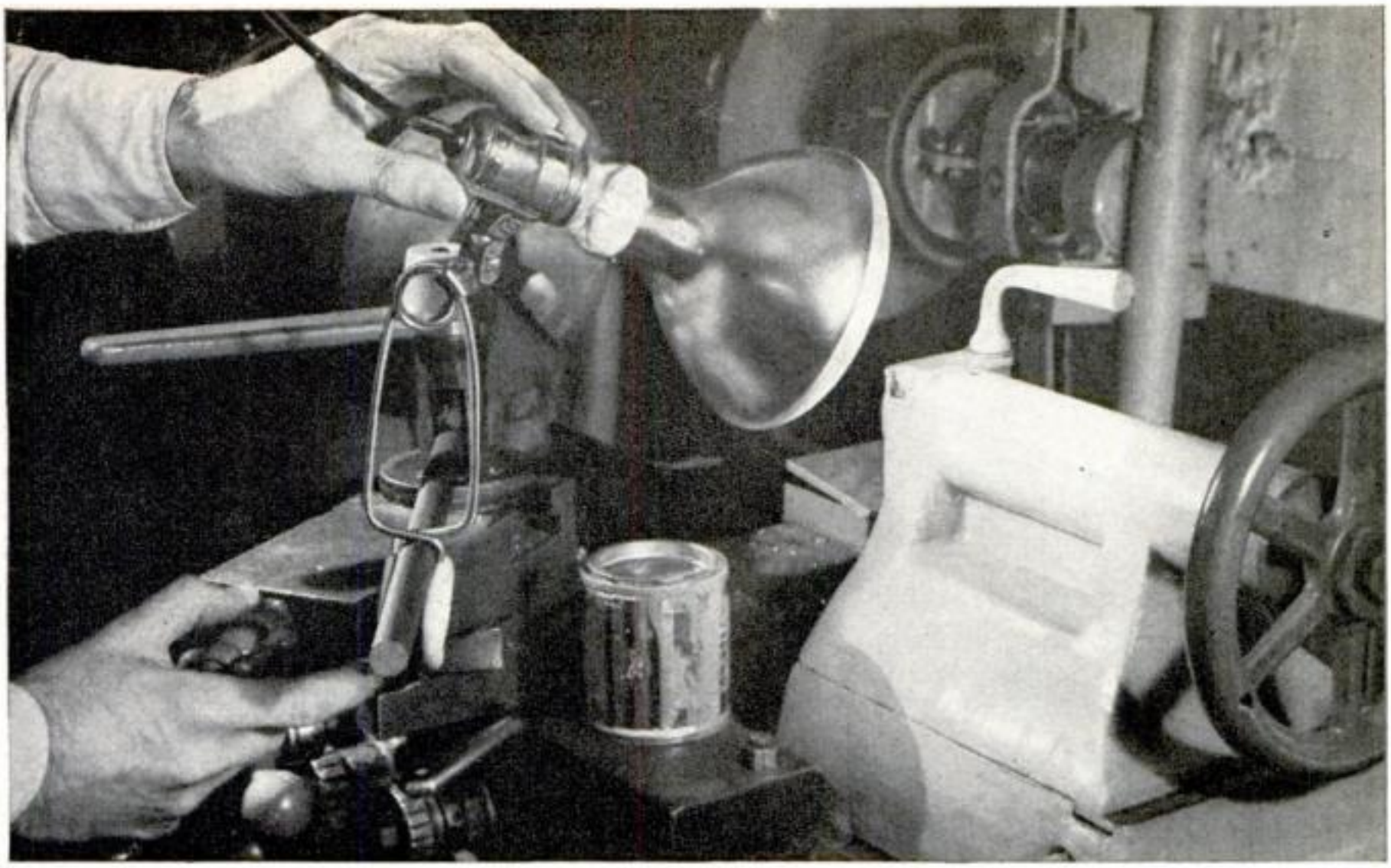



THIS stand is suitable for a flowerpot or a goldfish bowl. The columns may be molded or left plain, and are mortised into the top and base.

Shape the reverse-curve molding on the apron, then plane down the flat part to ⅝" thickness before making the cove. The same applies to the base. Miter the apron around the top, using glue, with nails driven from behind. The base is built up with ¾" by 2½" stock mitered flat around the underside of the molded part. Note that the feet project ⅜".—E. M. L.

## Sanding Renews Surface of Typewriter Platen

A GLAZED typewriter platen that allows paper to slip can sometimes be reclaimed by mounting it in a lathe and sanding the surface with fine silicon-carbide paper. Sand only enough to obtain a uniform dull surface the full length of the platen.



# Infrared Lamps Heat and Dry Work in Shop

HOME workshops and other small shops have dozens of everyday jobs that can be speeded up or made easier with lamps designed to produce infrared or heat rays rather than light. Many types of drying lamps are available, but for the average shop a 250-watt lamp of the kind illustrated is probably the most convenient. This lamp has a built-in reflector. Two precautions should be observed when using it: Do not splash water or other liquid on the glass when it is hot, and take care to protect the bulb from mechanical damage.

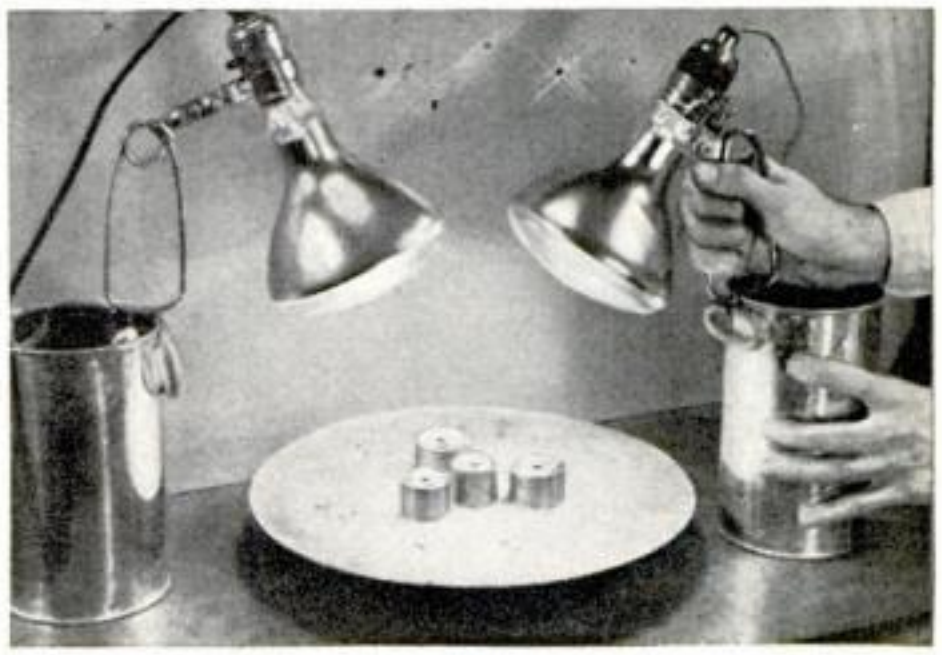
For all-around shop use the lamp can be attached to various supports by means of a spring-clamp arrangement on a medium-size screw push-button or key socket. For use on a bench or table, the lamp may be clamped to a tin can weighted with scrap iron.

Paint drying is the most common use for these lamps. The infrared rays penetrate the paint film, heat it and the metal or other material underneath, and thus dry the paint uniformly all the way through. Aim the lamps at the surface covered by the paint, but keep them far enough away so that the paint will not blister or become spongy. This should be determined by test.

For uniform drying of painted articles when one or two lamps are used, a revolving platform like that at the right can be devised. It consists of a circular metal disk mounted on a ball-bearing spindle, spun by a small motor or by hand.

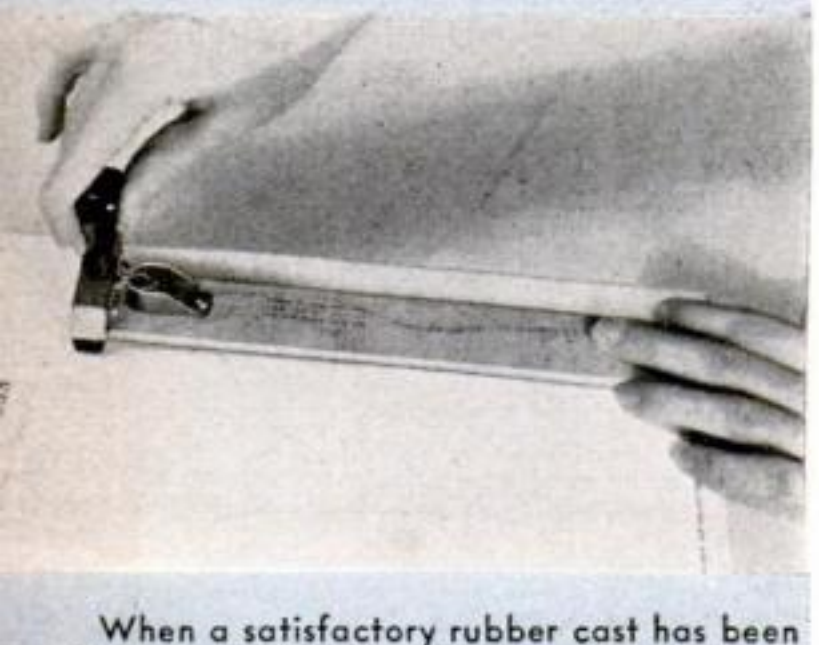
Other small-shop uses for infrared lamps include: removing excess moisture from things that moderate heat will not damage; baking motor armatures or other electrical parts impregnated with insulating compound; quick drying of rust-preventive coatings applied to metal surfaces; softening tar or other material that has a low melting point; preventing or eliminating frosting and steaming of windows; and warming the oil in delicate mechanisms that cannot be heated conveniently by ordinary methods.

Using two infrared lamps to dry lacquered metal parts, which are revolved on a turntable to insure uniform exposure. Above, drying paint on a lathe tailstock



The lines of lead type, tightly clamped together, are pressed into a soft layer of paraffin previously poured on a piece of glass. This is the mold for the rubber

Next, liquid rubber (in this case white) is thinly applied to the wax mold with a medicine dropper, brush, or stick. Turn the glass over to inspect for air bubbles



When a satisfactory rubber cast has been obtained, it is backed with sponge rubber and mounted in a holder. Above is a finished stamp with a simple aligning device


# RUBBER STAMP MAKING

BY GILBERT RAE SONBERGH

BY CASTING liquid self-vulcanizing latex in a wax mold, you can make satisfactory rubber stamps for home or office use at a fraction of their usual cost.

The first step is to have the "copy"—the name or other matter to be cast in stamp form—set up in type. A local job-printing shop will usually do this for a small sum. Ordinary linotype "slugs," as they are called, will serve, but if the copy is set in regular foundry type the resulting stamp will be much more satisfactory. The greater height of hand-set type makes higher, more durable letters on the stamp. In general, the type should be plain, not much smaller than 10 point, and perfectly clean.

To make the mold, the type must be securely held together and perfectly aligned. If a number of different single-line stamps are to be made, the several lines of type can be clamped together and a single mold made, the resulting rubber cast being cut up into individual lines. A small C-clamp can be used to lock together several linotype slugs, as shown in an accompanying photograph. Hand-set type can be clamped between strips of hardwood.

Although the impression can be made on warm paraffin in a small tray, a better method is to pour a ⅛" thick layer of melted wax on a sheet of glass. When it has solidified but is still warm and soft, press the type into it until the letters can be plainly seen against the glass from the reverse side. Remove the

A signature stamp is made in the same general way, but first the writing must be traced or photographed (reversed) on a cherry or other hardwood block and routed out as shown at left. This is used like type to make the original impression. At the top of the next page is shown a timesaving stamp rack


type at once, taking care not to mar the impression. Should this happen, do not try to insert the type again, but make a new impression on a fresh part of the wax.

Special care is required, when making stamps having two or more lines, to align the type or linotype slugs perfectly before making the impression. Even a slight misalignment may cause part of the finished stamp to print lightly or not at all.

The mold is allowed to cool to room temperature before the liquid rubber is poured into it. Several brands of self-vulcanizing liquid latex are on the market; the variety used to make rubber molds of heads or figures to be cast in plaster is more satisfactory than common black rubber intended for repair work. The latter must be shaken up before it can be used, and air bubbles inevitably form. Rubber-mold latex is stocked by the larger art-supply stores; mending rubber is now obtainable even in ten-cent stores, although the supply is limited.

Tilt the wax mold sharply and let the liquid rubber run into the fine lines of the impression from a small brush, an eye dropper, or the end of a stick. Fill the mold only to the shoulders of the letters; then inspect it from the underside of the glass against a strong light and carefully break any air bubbles. If there are corners into which the latex has not penetrated, work it into them with a brush or the head of a pin.

Set the partially filled mold aside for from one to three hours—in a warm place if you wish to hasten the process. Then examine it again by transmitted light, and if it is satisfactory, pour in more liquid rubber to a height of ⅛" above the shoulders and set the mold aside in a warm place for 12 hours.

Before removing the rubber from the mold, make certain it has set completely. A sharp point pressed against the surface should leave no mark. The color of the rubber should be uniform; if much milkiness remains, let the cast set a few hours more. Removing it before the latex has thoroughly set may pull the stamp out of shape.

Trim off excess rubber with wet scissors or a razor blade dipped into cold water. Mount the stamp on a ¼" thick cushion of sponge rubber slightly larger in area than the lettering. Thus mounted, it can be attached with rubber cement to a block or handle of suitable size. Professional mounts have the sponge rubber attached, and are sold in strip form. The desired lengths are cut off and drilled for ready-made handles. Many mounts of this kind have a metal molding into which a label corresponding to the stamp can be inserted for identification.

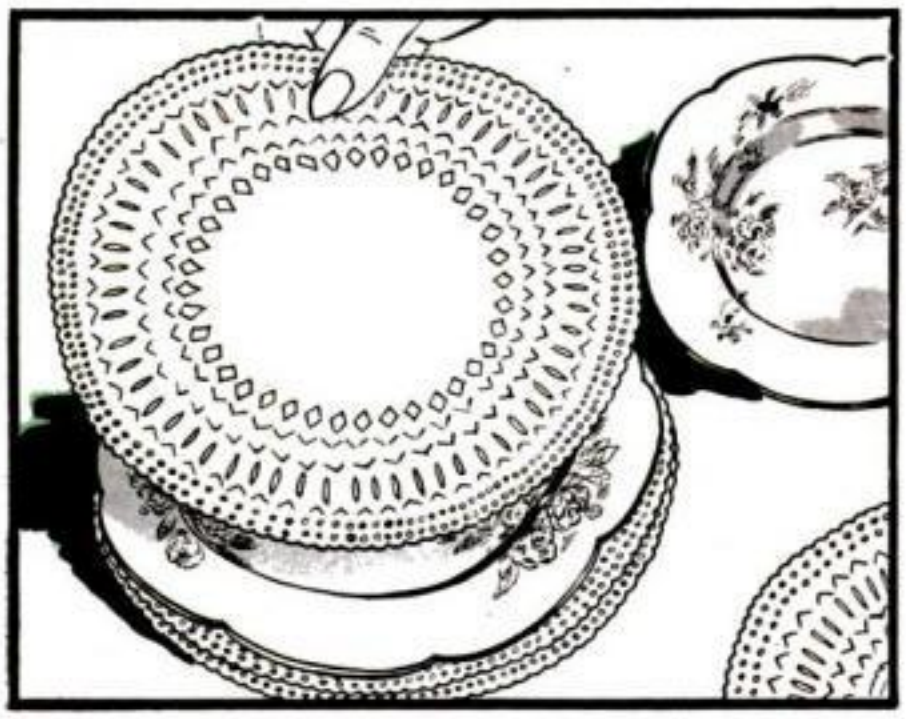
As many rubber stamps as desired can be cast in the same mold, provided care is taken in removing each strip so as not to damage the delicate wax ridges. Use care in handling homemade stamps for a week or so after they are made; after that time the rubber becomes as tough as that of any commercially made stamp.

# KEEPING

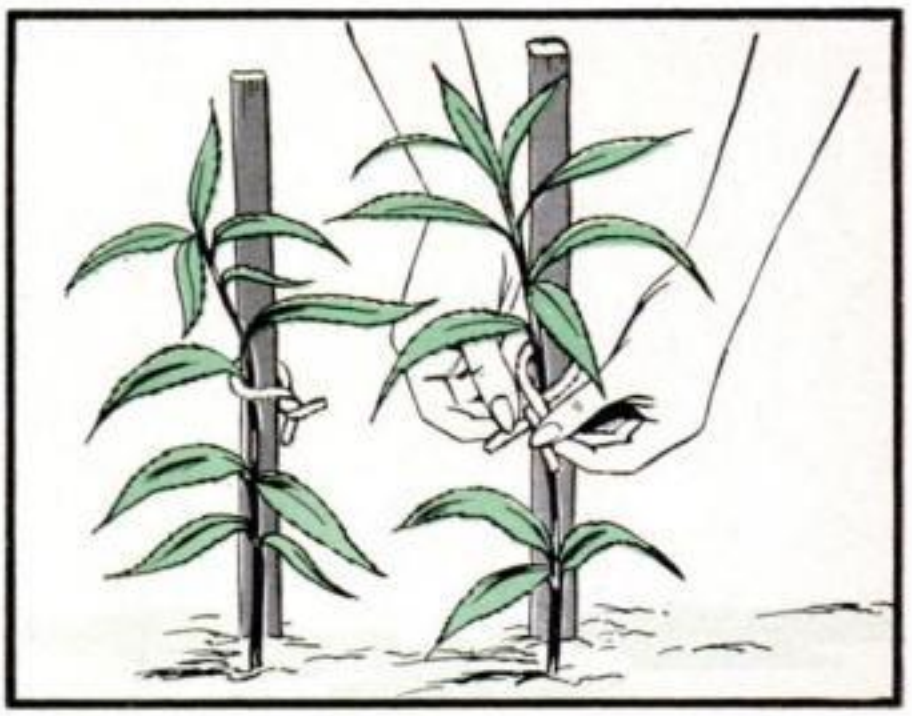

Silverware can be cleaned easily with the help of a cellulose sponge used as a pad. The sponge is soft and pliable, holds polish readily, and can be washed out quickly when the job is completed

Packing a layer cake to reach a picnic in good condition usually requires an extra box or one having separate compartments. An ordinary carton can be made to serve just as well by slitting it at the corners as shown, and drawing a heavy cord through the slits to support a corrugated-paper shelf. The other food is put in the top section

Coffee cream, put in a syrup pitcher which has a no-drip pouring cap, can be carried to a picnic without danger of spilling. The cap will also act as protection against flies and other insects

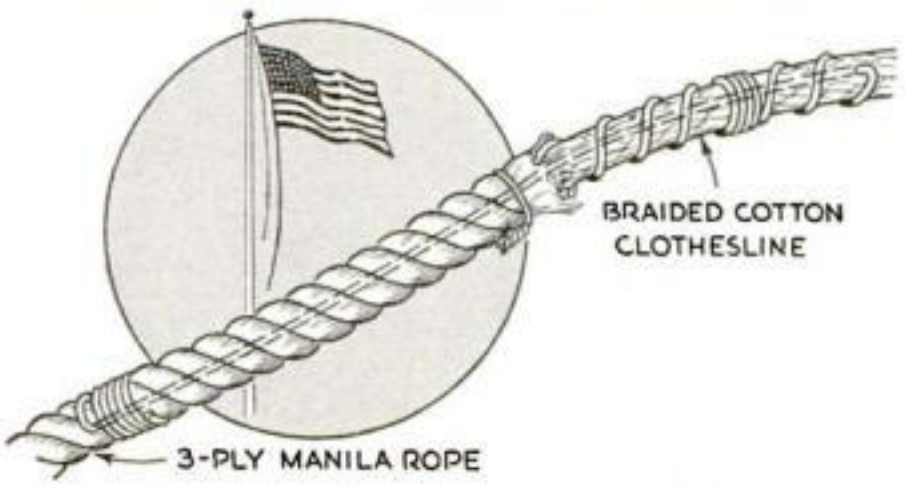


Lace paper doilies, placed between pieces of fine china when they are stacked up on closet shelves, will keep hand-painted decorations and gilded edges from rubbing. The doilies can be obtained in a variety of sizes to fit all pieces in a set from small side plates to the largest platters

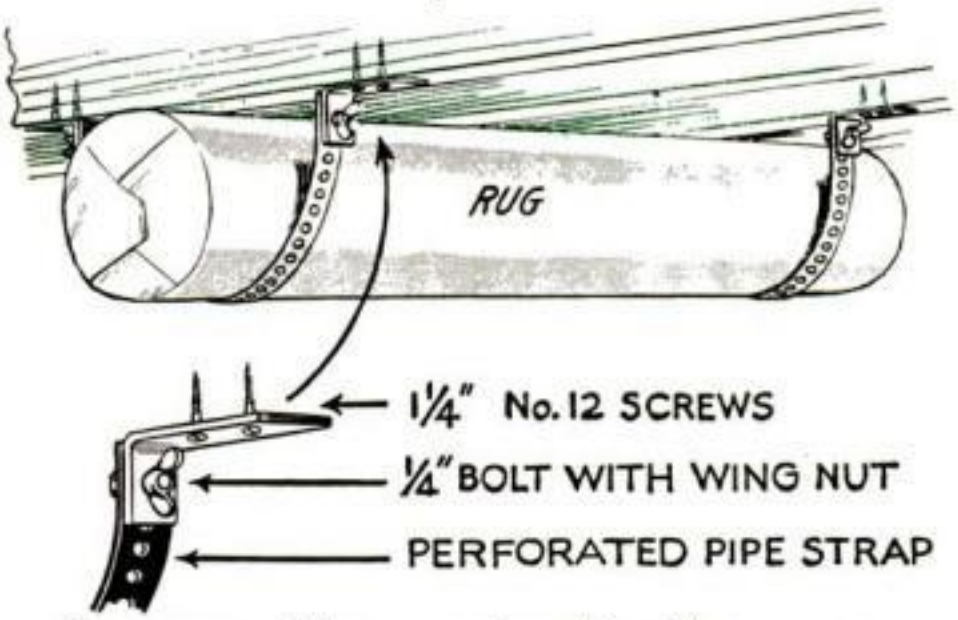


Ordinary pipe cleaners may be used effectively in a garden to fasten young plants to stakes, their soft, cotton covering guarding the stalks from bruises. The cleaners can be twisted into place quickly without tying. They are not conspicuous, but if desired, they may be tinted with green ink

# THE HOME SHIPSHAPE

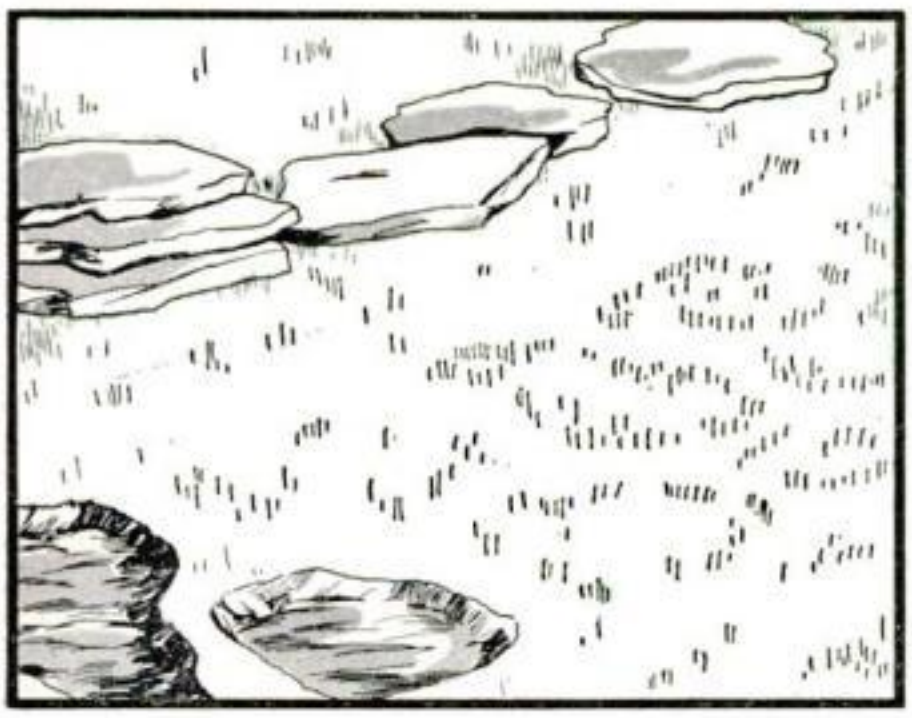



To splice dissimilar lines temporarily to go over a pulley, lay rope strands over a wire core, file wire to a point, push it through braided line with pliers and out. Wind ends of wire toward juncture

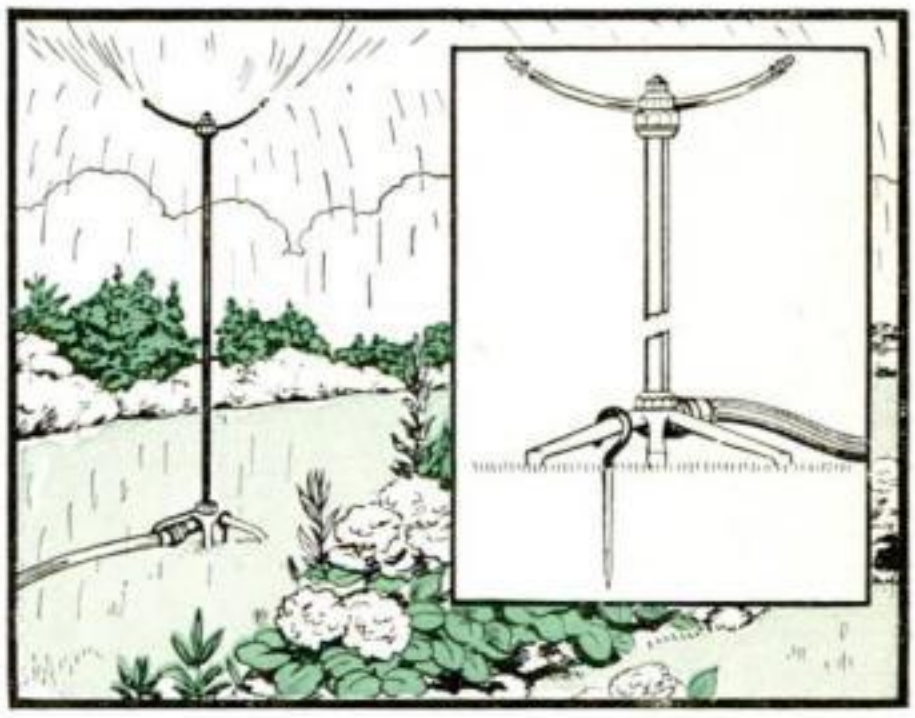



Summer or winter rugs, stored in off seasons, may be kept safe from basement-floor dampness if they are hung up on overhead racks. Screw four angle brackets to joists as shown, first sawing one leg short if desired, and secure the rug with lengths of perforated pipe strap bolted to the fixtures. Wrappings of heavy paper will protect from dust

For a professional rubbed finish on turned chair and table legs, use an ordinary soft-bristle shoe brush instead of a rag, which might leave sharp white edges. Wet the bristles with crude oil or water, as required, and sprinkle on rottenstone or pumice, which can be sifted and applied in one operation by shaking through an old silk stocking



Outlines for removing sod preliminary to laying a flagstone walk may be obtained simply with lime or some other white powdered substance sprinkled over the stones while they are temporarily in the positions they will occupy. Dig deep enough for the tops of the flags to rest at the desired level



Inserted in a low sprinkler between the base and head, 3' of pipe adapts it for the garden as well as the lawn. This improvement will permit water pressure to be used at full force without danger to nearby plants. A hooked spike pushed over one leg keeps the pressure from overturning the stand

# Questions and Answers

## By MAURICE WHARTON

HERE are questions relating to some common painting and finishing problems, with answers based on the best professional practice:

*My house is to be shingled and I want to finish the shingles in white. What is the best method?*

It is good practice to dip the shingles—at least for the priming coat—before putting them on. Each should be dipped two thirds to three quarters of its length, with the butt end down, leaving the thin top part bare of paint. One or two coats should be applied after the shingles have been nailed on. Some manufacturers make shingle stains and paints ready for use—generally a primer for the dipping coat and a stain or paint for brushing.

*How is a pickled-pine finish produced?*

Pickled wood effects are produced easily by coating the surface with white oil paint and wiping off all but that which remains in the grain. Another method is to rub white paint into the grain with a cloth. In either case the surface is sanded after the paint is dry and a coat of flat varnish is applied. When the varnish is dry, apply paste floor wax, leaving it flat or rubbing it lightly with a dry cloth for an eggshell finish.

*How can I keep from darkening knots and rough places in staining knotty pine?*

Apply raw linseed oil and turpentine mixed in equal parts, or liquid shellac thinned with an equal amount of denatured alcohol, before the stain is put on. When the primer is dry, use an oil stain, wiping off as much as necessary at any point. In this way the depth of the stain may be controlled.

*Does varnish give a good, durable finish on a floor?*

High-grade floor varnish produces a fine, long-lasting finish. After a new floor has been properly filled (if of oak or other open-grained wood) and the filler has dried and hardened, apply a first coat of varnish, thinned with genuine turpentine according to the manufacturer's directions. After this has hardened, remove the gloss with No. 0 or No. 00 sandpaper, dust carefully with a clean, soft brush, and apply a coat of unthinned varnish. This is sanded like the first coat, and a third coat is then applied. Ample drying time and light but thorough sandpapering between coats insure a satisfactory job. A floor so finished may be waxed occasionally.

*Three weeks after shellacking and varnishing interior woodwork, the surface is still sticky. Can you offer a remedy?*

It is possible that the varnish was old and had become "fatty," or that polish containing wax was not removed before the shellac and varnish were put on. Apply a solution of one-half pound of powdered borax in a gallon of water. If this does not eliminate the tackiness, it will be necessary to remove the finish, thoroughly clean the surface, and refinish.

Dipping makes shingles look better and last longer

Wiped white paint will give a pickled-wood effect

# on Painting Problems

*How can hard, close-grained and open-grained woods be finished natural? I have a room in which the trim happens to be genuine teak and Brazilian rosewood.*

For any hard, close-grained wood, such as teak, two coats of shellac thinned with an equal amount of denatured alcohol are a suitable filler. Sand with No. 00 or No. 000 paper, and apply prepared wax or varnish.

Rosewood, which has a more open grain, requires one or two applications of high-grade paste wood filler, tinted to match the wood. When dry, sand the surface lightly, dust, and apply a coat of one-half liquid shellac and one-half denatured alcohol. For good luster, apply two or three coats of wax and polish with clean cheesecloth. For a polished varnish finish, apply two or three coats of varnish and let stand for two or three weeks; then rub with powdered pumice stone and water and polish with powdered rottenstone and oil. If an open-grained wood is to be stained, the staining must precede the use of paste wood filler. When the filler is thoroughly dry, apply a thin coat of shellac and follow with varnish or wax.

*How should the colors "off-white" and "powder blue" be mixed?*

For off-white, add a very little raw umber to white-lead paste or prepared white paint. The tinting color should be thin, and added only a drop or two at a time. For powder blue, mix Prussian blue and raw umber in equal parts, and add to white-lead paste or prepared white paint a little at a time until almost the desired shade is produced. At this point you can tell whether a little more blue or umber should be added.

*I have tried various makes of paste, hot and cold, in attempting to apply wall paper on wood-fiber plaster. It seems that the suction of the plaster takes up the paste and the paper comes off.*

Size the wall to stop the suction by applying a coat of paint followed by a coat of glue size a bit stronger in glue than ordinarily needed. Or apply a size coat, sandpaper the wall, and apply a second coat of size. You may make the paste exceptionally elastic by adding molasses, Venice turpentine, brown sugar, or corn syrup. Mix the best quality of wheat flour with a little cold water and break up the lumps; then pour boiling water on, stirring all the while. When thin enough and still hot, pour in a little corn syrup. After this has been thoroughly mixed, pour a little cold water on top to prevent skinning over and let the paste cool.

*How can I wash overalls that have quite a lot of paint on them?*

Soak the overalls first in clear water, then in a solution of 1 lb. sal soda in a gallon of hot water. Let them remain until the paint becomes softened. Next, wash them with laundry soap and warm water, using a scrubbing brush vigorously. Rinse with plenty of clear water, or apply the water with a large sponge, until the soap is all out of the cloth; then hang up to dry.

Wood-fiber plaster must be sized before papering

Varnishing a floor requires care in every operation

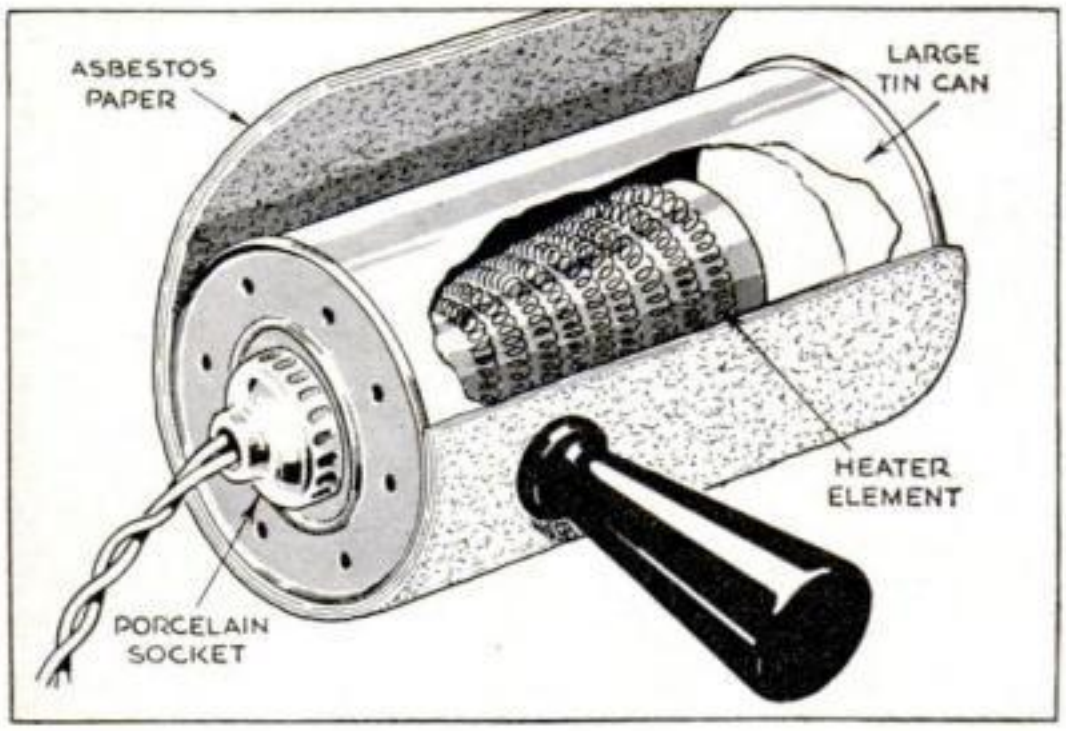
# Homemade Electric Heat Gun

## BURNS THICK PAINT OFF WOODWORK WITH SAFETY

FACED with the problem of removing a layer of paint several coats thick, Edgar Walker, of Milwaukee, Wis., solved it with the electric heat gun illustrated. It plugs into any wall socket, is light and therefore not fatiguing to use, and does not involve the fire hazard that a blowtorch would.

The body of the gun is a large tin can, having a circular hole cut in the closed end for a porcelain lamp socket—the kind having a threaded collar that may be screwed on from the inside of the can to clamp the socket tight. Punch a ring of holes around the socket to allow air circulation. Wrap two or three layers of asbestos paper around the can, as it will otherwise radiate enough heat to make it uncomfortable to hold.

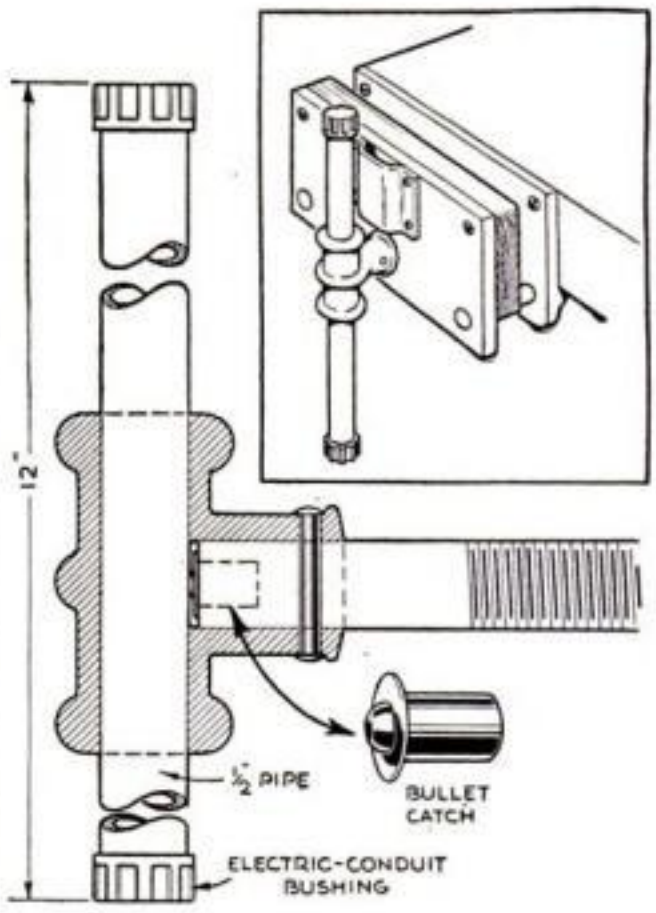
A sturdy wooden handle is attached at the proper point to make the gun balance in the hand. One from an old kitchen utensil may do. Connecting a cord and inserting a cone-shaped heater element make the unit ready to use. Hold it just close enough to the paint to cause blistering. The paint can then be removed easily by scraping it with a putty knife.




At left, a cut-away view of the homemade electric paint remover. Use only a porcelain socket and asbestos-covered cord. Tie asbestos-paper wrapping on with wire

# Bullet Catch Improves Action of Iron-Pipe Vise Handles

ONE school industrial-arts department replaced a number of broken woodworking-vise handles with 12″ lengths of ½″ pipe. Electric-conduit bushings were screwed on the ends of each piece, and to prevent these unbreakable handles from dropping noisily and from pinching fingers when carelessly released, a standard bullet cupboard catch was fitted into the end of each vise screw. This was done by driving out the rivet that held on the handle collar and drilling a hole of appropriate size lengthwise of the vise screw to receive the bullet catch, as is clearly shown in the drawing at the right. The collar was then replaced and the rivet peened over again to hold it fast. The handles work smoothly and have a neat appearance.—A. L. MAXFIELD.



Pearl luster is applied on one small area at a time for the finish magnified 100 diameters in the photomicrograph below

# Synthetic Pearl Finish Adds Luster to Small Carvings

PROPERLY applied, a coating of synthetic pearl, or "pearl luster" as it is sometimes called, adds greatly to the appearance of carvings, plaster casts, synthetic stone compositions, and such small work.

Synthetic pearl is prepared from barium chloride and hyposulphite of soda (photographers' hypo). Dissolve 4½ oz. of barium chloride in 12 oz. of water in a beaker or other chemical-resistant vessel. In a second beaker dissolve 4¾ oz. of hyposulphite of soda in 25 oz. of water. Filter both solutions. Heat the hyposulphite of soda solution to 80 deg. C. (176 deg. F.) and add it to the barium chloride solution, stirring gently. A heavy precipitate of barium hyposulphite in glistening crystals will form and settle quickly to the bottom.

To purify, pour off and discard the clear solution. Add water to the precipitate and stir it gently for a short time. Allow the precipitate to settle, and again discard the clear solution. Wash the precipitate in this way in seven changes of water, then spread it on clean blotting or filter paper and dry it at room temperature.

Application of the synthetic pearl coating requires care, but is not difficult. The work should first be given a heavy coat of enamel of a type that is soluble in acetone. Your paint dealer can advise you on that point. Use a white enamel or one that is tinted faintly, and allow it to dry thoroughly.

Place some of the pearl powder in a small dish and cover with acetone. Dip a camel's-hair brush into the mixture, stir, and pick up a generous amount. Quickly and in one short stroke, apply the brush to a small area of the enameled surface. The acetone solvent will soften the enamel sufficiently to cause the powder to adhere. Take up another brushful and apply it to a second small area, and repeat until the entire surface is covered. When the coating has dried, dust carefully with a dry brush to remove surplus powder and uncover bare spots. When these places are touched up and dry, cover the entire surface with an even coat of clear lacquer.

Should acetone-soluble enamel be unavailable, good results may still be had by using any hard enamel covered with a bonding coat made from the following formula: Shred 1 oz. of celluloid into a wide-mouth bottle fitted with a screw cap and add 12 oz. of acetone. Old photo film, from which the gelatin has been removed by soaking in caustic soda or caustic potash, is a satisfactory celluloid.

Thoroughly agitate the celluloid and the acetone from time to time until all the celluloid has dissolved, and then mix thoroughly with 5 oz. of 95-percent ethyl or methyl alcohol and 4 oz. of amyl acetate or cellosolve acetate. Use two coats of this compound for the bonding surface which, when dry, will hold the synthetic pearl powder and acetone readily.—K. R. SIPPLE.

Spending pennies for new bulbs may save you dollars in current. Blackened bulbs are 20 percent less efficient. Query: Which gives half again as much light, one 100-watt or four 25-watt bulbs? See text for the answer

# Saving

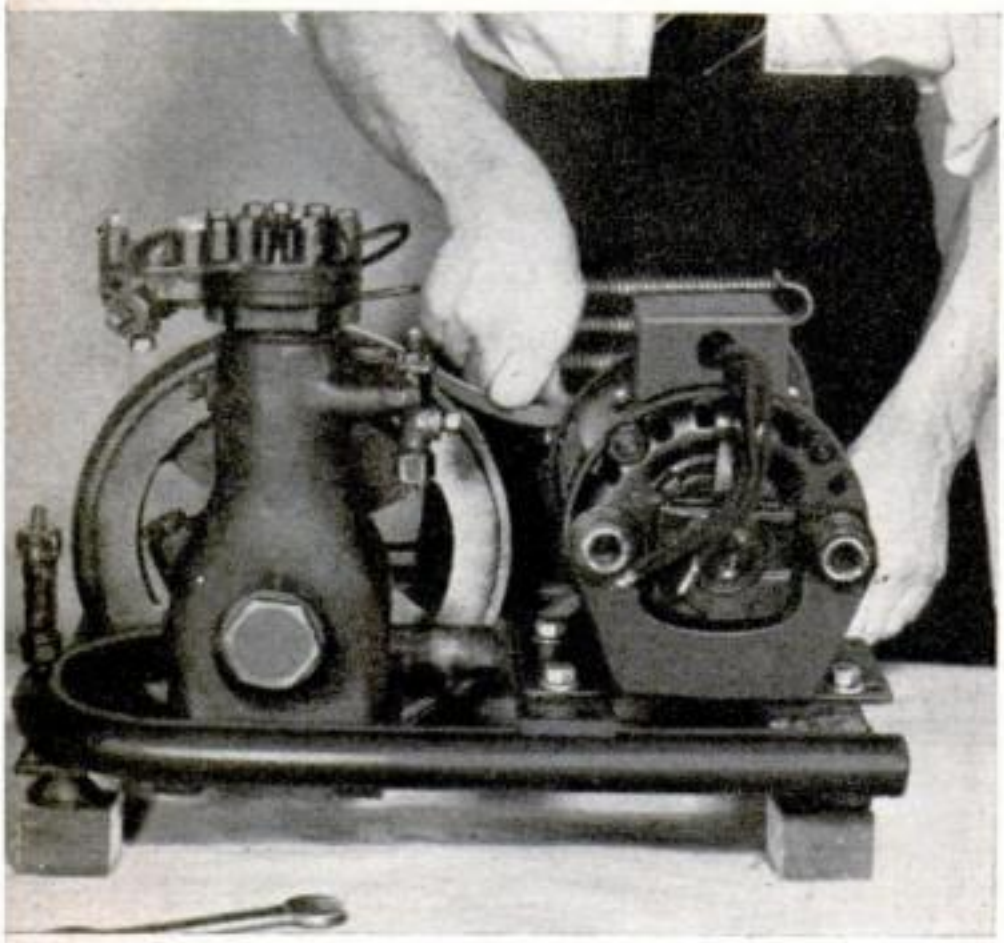
## By Harold P. Strand

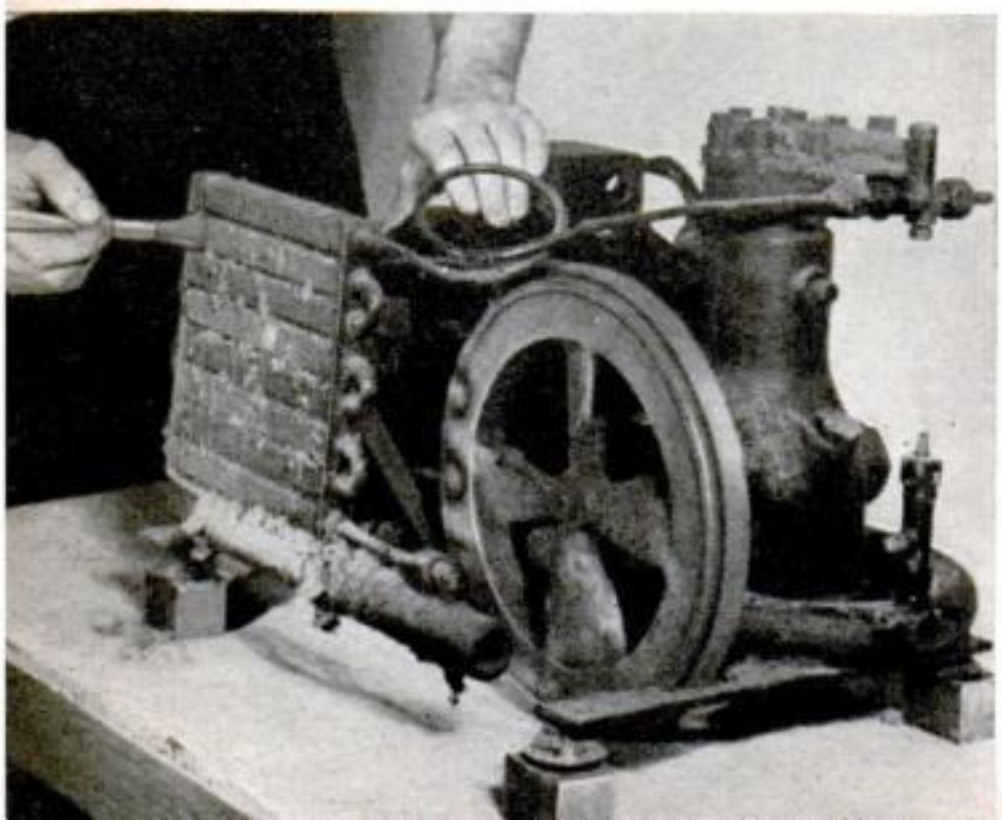
NOBODY benefits when you pay for electricity you don't need, but your pocketbook suffers. If your monthly bill is bigger than you think it should be, why not check up on your meter, your house wiring, and your use of accessories along the lines suggested in the following paragraphs? The chances are you'll make a saving—and saving electricity is helping Uncle Sam.

This same energy that provides you with refrigeration, runs your oil burner, washes your clothes, and lights the page you read is today one of the chief materials of production. It provides power for factories, turns ore into metal, and does work in mines, on railroads, in shipyards. The duty of every patriotic citizen is to conserve it, that there may be enough to meet the nation's needs.

An obvious but much-neglected way of saving electricity is to turn off all lamps not needed and radios to which nobody is listening. This can in some cases make a surprising difference in the monthly bill. A common habit that wastes current is allowing a large console radio to play steadily most of the day and evening. As many of these receivers draw from 75 to 150 watts, they add considerably to current consumption. It is better to have a small table model besides, and to use this for listening to most of the broadcasts, reserving the large receiver for musical and other programs that are better appreciated through the larger speaker. In this way, you will be using only 50 watts or less most of the time.

Blackened lamp bulbs waste current. Such a bulb burns about 20 percent less efficiently than a new one, and may make it necessary to turn on a second lamp to





A belt-driven refrigerator unit requires checking occasionally to keep current consumption down. If a belt can be depressed much more than ½" (center photo), it may be slipping. Dirt in fins (at left) retards air flow around tubes and cooling of the refrigerant. Clean off the entire unit thoroughly


# Electricity in the Home

get sufficient light, whereas a single new one would suffice. Light-colored walls and ceilings that reflect light make it possible to use smaller lamps; dark surfaces that absorb light may force you to use bigger ones. Keep the glass shades and bowls of lighting fixtures clean, and use light-colored translucent parchment or silk shades on table and floor lamps. Don't use colored bulbs for illumination.

Having the light source near the work makes it possible to use smaller bulbs, but place lamps so that there is neither direct nor indirect glare into the eyes. Whenever possible, use a single high-wattage bulb instead of grouping several smaller ones. A 100-watt bulb gives 50 percent more light than four 25-watt bulbs consuming the same amount of current.

Poor room arrangement and ill-placed switches may cause you to waste current. Little can be done about the first, but changing the location of a switch from the middle of a wall to near the doorway may make it easier to turn out the lights when leaving a room.

One of the commonest ways of wasting current unintentionally is to forget to turn off the cellar lights and so leave them burning all night. Perhaps the best insurance against this nuisance is a pilot lamp. This is a very small bulb placed in a receptacle behind a ruby glass and located on the kitchen wall. It can be installed either in a separate receptacle wired to any convenient spot on the wall to which cable can be fished up from the cellar, or in a combination receptacle of the kind shown in a photo on page HW 108. The wiring diagrams for both separate and combination receptacles are given near that photograph. In either case, the pilot lamp is connected in parallel with the cellar lights.

Another thing that may waste electricity is a condition of slight "grounds" existing in one or more circuits. This means there is current leakage through the insulation somewhere—not enough to blow the fuses, but sufficient to make the meter turn slowly all the time. To test for this, turn off all lights, pull out all cords including those of clocks and radios, and disconnect the bell transformer. Then look closely at the meter disk. It should be absolutely at rest. If it turns at all, remove the fuse or fuses from each circuit in turn. When the grounded circuit is cut out by removal of a fuse, the meter disk will stop. Check each fixture and outlet in the faulty circuit for poorly taped joints and for stray strands of wire at the top splice or at the sockets that may be in contact with grounded metal. An old water leak that has soaked the wiring may be responsible for partial grounds. Thorough drying out or rewiring is the remedy.

In rare cases, the meter disk will turn slowly with all fuses removed, even though no ground is present. This indicates a "creeping" meter and should be reported to the power company.

Automatically controlled devices such as oil burners and refrigerators must be watched, for if they are not properly adjusted, their "on" periods may greatly exceed their "off" periods, with a resulting waste of fuel and electricity.

*Oil burners.* High thermostat settings come first among the causes of high fuel and power consumption. An average temperature of 70 deg. in the home is both healthful and economical. If at this setting you use 2,000 gal. of oil yearly, according to figures published by a major oil company, increasing the temperature to 75 deg. will cost you 286 gal. more, and proportionately more electricity to run the motor. At 80 deg., you will be wasting 572 gal., and 250 kilowatt-hours will be added to your electric bill. If you are not comfortable at 70 deg., make sure the humidity is not lower than it should be. Excessively dry air may seem to make unreasonably high temperatures necessary for comfort. Use evaporating pans or other means to raise the humidity, and keep the temperature down to 70 deg.

The average gun-type oil burner uses a 1/6-h.p. motor, taking 350 to 400 watts. Re-

Here's a chart of average operating costs for the most popular appliances. Remember, however, that the way you use an appliance makes a difference in the amount of current it consumes

## APPROXIMATE COST OF OPERATING ELECTRIC APPLIANCES

**Note:** This tabulation is reprinted from **The Care and Use of Electric Appliances in the Home**, published by Westinghouse Electric and Manufacturing Company.
Kilowatt-hour (kwhr.) is the measuring term applied to electric current, as gallons is the term applied to water. It means 1,000 (kilo-) watt-hours of electricity.

| APPLIANCE | Average kwhr. consumption | | Average cost, based on 3.73 cents per kwhr. rate | |
|---|---|---|---|---|
| | Monthly | Weekly | Monthly | Weekly |
| Refrigerator | 28.66 | 6.61 | $1.07 | $0.25 |
| Range | 85.00 | 19.61 | ....* | ....* |
| Roaster | 18.75 | 4.32 | 0.70 | 0.16 |
| Iron | 5.33 | 1.23 | 0.20 | 0.05 |
| Ironer | 8.33 | 1.92 | 0.31 | 0.07 |
| Washer | 2.00 | 0.46 | 0.07 | 0.02 |
| Water heater | 218.00 | 50.48 | ....* | ....* |
| Vacuum cleaner | 1.66 | 0.384 | 0.06 | 0.01 |
| Dishwasher | 1.25 | 0.29 | 0.05 | 0.01 |
| Coffee maker | 7.3 | 1.7 | 0.27 | 0.06 |
| Toaster | 2.5 | 0.5 | 0.09 | 0.02 |
| Waffle iron | 5. | 1.1 | 0.19 | 0.04 |
| Sandwich grill | 2.8 | 0.6 | 0.10 | 0.02 |
| Fan | 3.3 | 0.8 | 0.12 | 0.03 |
| Heating pad | 1.5 | 0.3 | 0.06 | 0.01 |

*In practically all communities special lower electric rates prevail for ranges and water heaters. Operating costs figured on the 3.73 cent rate used for other appliances would not, therefore, give a true picture.

move soot and carbon occasionally from the combustion chamber. Keep ignition points clean and properly spaced. If the flame does not appear to be full, attention should be directed to the burner nozzle. Clean this and check the tiny hole in the end of the nozzle, as it may be partially stopped up. A fine piece of wire can be used to clean it out if necessary. A clogged jet may cause a burner to run almost constantly.

A frequent cause of irregular operation is dirt on the oil strainers. These should be cleaned occasionally. See that motor bearings get periodic lubrication. Electrical contacts in the automatic controls may become dirty and pitted, requiring cleaning and adjustment.

An indirect hot-water heater attached to the boiler puts an additional load of as much as two square feet of radiation on it for each gallon of water stored. If hot water is wasted, electricity and fuel will be also. The boiler and all piping should be well insulated, as should hot-water storage tanks.

*Refrigerators.* Modern sealed-unit refrigerators generally use less electricity than belt-driven machines. Their efficient mechanisms require only 1/12- to 1/8-h.p. motors in the average family size.

However, a little care given belt-driven refrigerators will keep their current consumption within reasonable limits. To illustrate better the work involved, a typical unit was taken out of its cabinet, as shown in two of the accompanying photographs, but the average unit can be serviced without removing it. Note the accumulation of dirt in the fins of the condenser, which retarded cooling and condensation of the refrigerant. A small brush and a hand vacuum cleaner with a blower tube are excellent for removing loose dirt. All other parts should be thoroughly cleaned as well. Make sure the cord is pulled out of the wall outlet before touching the mechanism.

Motor brushes must be long enough to make good contact with the commutator, and brush springs should have sufficient tension. If worn too short, the brushes must be replaced. Sometimes they stick in the holders because of gummy dirt. Clean both brushes and holders with gasoline or some other solvent, preferably carbon tetrachloride, which will not burn or explode. The commutator should be cleaned with very fine sandpaper (never emery cloth) if it is dirty. With some types of motors, it may be necessary to remove the end bearing housing in order to get at the commutator and brushes.

Test the belt for looseness as shown. If you can depress it much more than ½", it may be slipping on the pulleys. Loosen the motor bolts and slide the motor back to take up the slack, but do not make the belt too tight, as it will cause wear on the bearings and make the motor labor. If the belt has

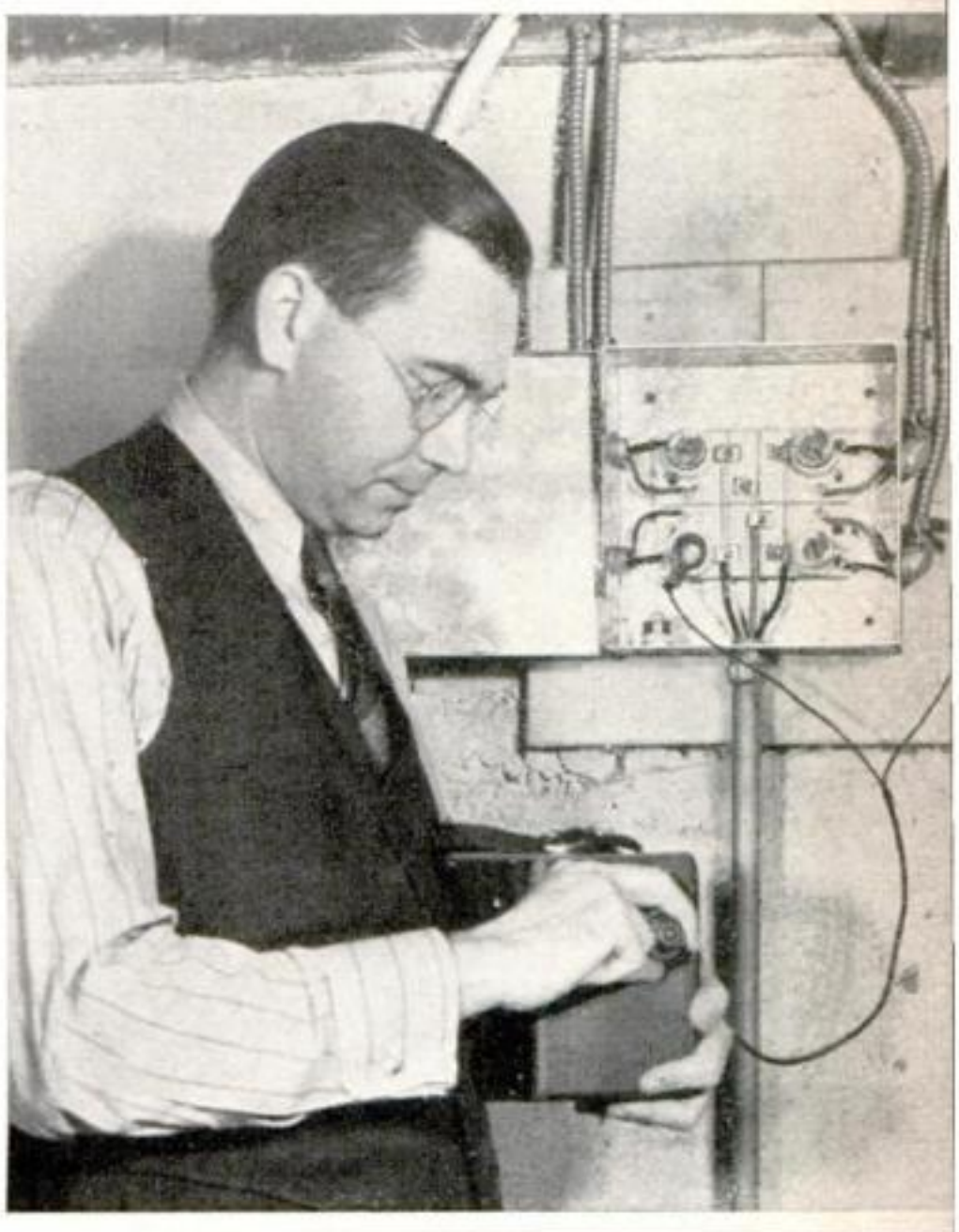
Room temperatures above 70 deg. are unhealthful and make fuel and electric bills soar. Check the humidity if comfort requires a higher themostat setting. The real trouble may be excessive dryness

stretched beyond adjustment, obtain a new one and reset the motor to suit it.

*Electric ranges.* Where electrical companies offer reduced rates, ranges can be used economically, provided a few precautions are observed. Don't, for example, open the oven door frequently when baking. It lets heat out and wastes electricity. Rely on the clock control instead. This is more accurate besides, and prevents overcooking. If your range has an "economy cooker," use it for the less tender cuts of meat and poultry that require long, slow cooking.

Instead of broiling a steak immediately after it is taken from the refrigerator, let it first reach room temperature. Broil vegetables together with meat to make full use of the current you are paying for.

In using the top elements, switch to a lower heat as soon as food reaches the boiling point. This conserves not only electricity, but vitamins as well. Re-



Electricians test for partial grounds with a hand-operated magneto that can ring a signal bell through a 50,000-ohm resistance. If the circuit is a sound one, the bell will not ring

## THESE REFRIGERATOR TIPS WILL SAVE YOU MONEY

See that the gasket around the door is clean so that it can make a tight seal. If it is loose or has deteriorated, replace it.

Don't put foods into the refrigerator while they are still warm.

Remember that quick freezing takes more electricity.

Set the cold control to provide a temperature of 40 deg. in the food compartment. A lower temperature is unnecessary.

Defrost the refrigerator regularly.

Open the door no oftener than necessary, and reclose it quickly.

Avoid overcrowding the shelves. Air must circulate inside the box.

Don't use your refrigerator for storage of cans and packages that will keep equally well outside it.


Saving hot water saves current, whether you have an electric heater or one connected to a fuel-oil furnace. Perhaps the water need not be kept so hot; a lower aquastat setting may mean lower bills

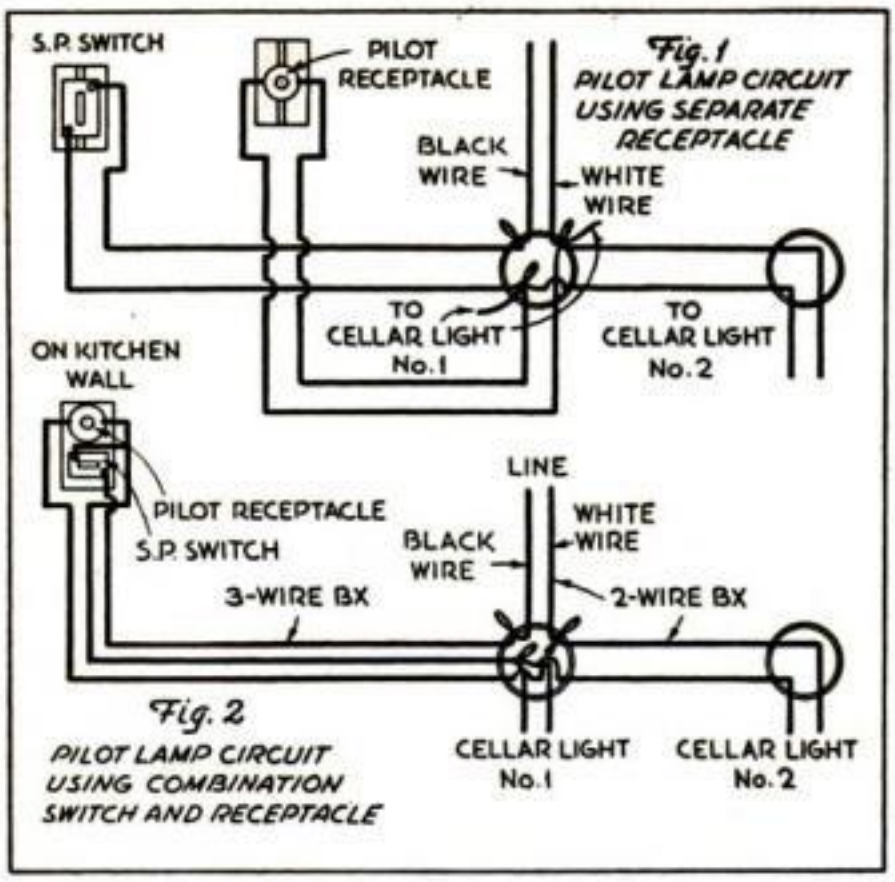
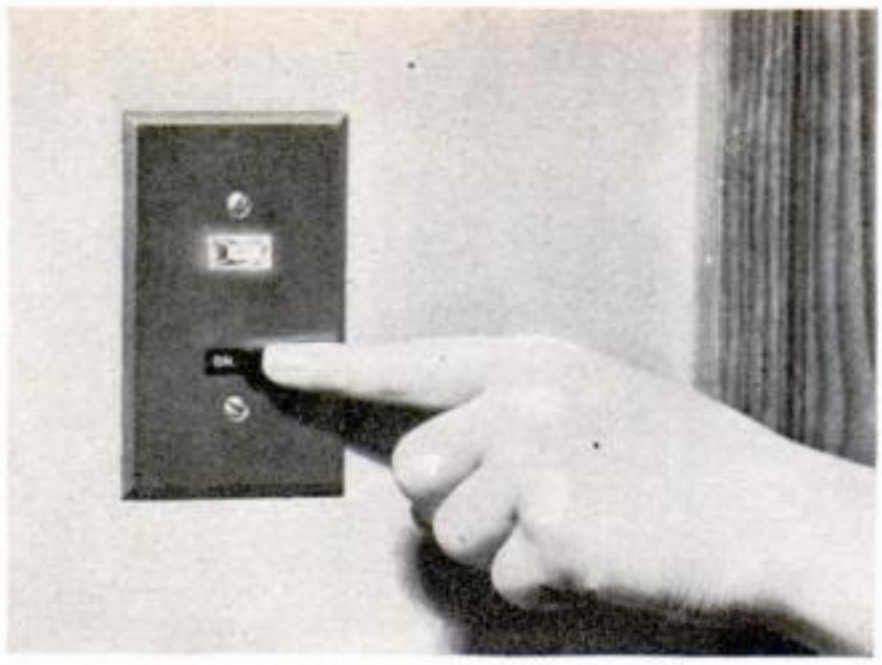



*Fig. 1*
*PILOT LAMP CIRCUIT USING SEPARATE RECEPTACLE*

*Fig. 2*
*PILOT LAMP CIRCUIT USING COMBINATION SWITCH AND RECEPTACLE*



Above, switch combined with built-in pilot lamp. How to wire this or a separate pilot lamp to warn when cellar lights remain on is shown at the left

member that much heat remains in the units after they have been shut off. Use this by turning them off a little before the full cooking time is up.

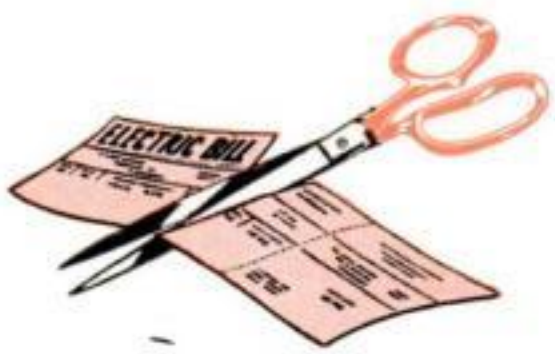
*Washing machines.* Do not run a washer longer than necessary. About 7 to 15 minutes is usually enough. Do not pack too many clothes in the washer or run too heavy a load through the wringer. This overloads all the parts, uses extra electricity, and is hard on clothes. Fill only to the water line indicated by the manufacturer, and use a good grade of soap. Remember that it is poor economy to start up a large washer to do a few small pieces. One of the small table-type washers will serve more economically. Unless of the oilless variety, motor bearings should be oiled regularly. Most washers have 1/6-h.p. motors taking from 350 to 400 watts.

*Ironers and hand irons.* Ironers usually draw from 1,050 to 1,320 watts, but are very convenient for family ironing. Of course, for a few pieces it is more economical to use a 660-watt hand iron. If yours is not an automatic one, pull out the cord from time to time to prevent overheating and waste of current. Do not go to the door or answer the telephone without first disconnecting the iron. You may be longer than you expect. Hang all flat work on the line as straight as possible, as it takes less ironing to do a smooth piece than one that is badly wrinkled.

*Roasters.* Portable ovens are quite popular now for cooking complete dinners or roasting large cuts of meat or poultry. However, they are wasteful of electricity when used to bake a small pudding or a few biscuits. As a large roaster draws 1,320 watts, it is uneconomical to use it at less than its full capacity.

*Portable room heaters.* Although convenient for warming a cold bathroom or taking the chill off a small bedroom, these are not economical for continuous heating. If the radiator in a room is not adequate, perhaps changing the pitch of the supply pipe will make it so, or a few more sections can be added to the radiator itself. Sometimes an additional radiator installed on the other side of the room will do the trick. In any case, heat supplied by the central heating plant will be far more efficient than electric heaters for continuous use, and considerable electricity will be saved, for such electric heaters consume from 660 to 1,320 watts.

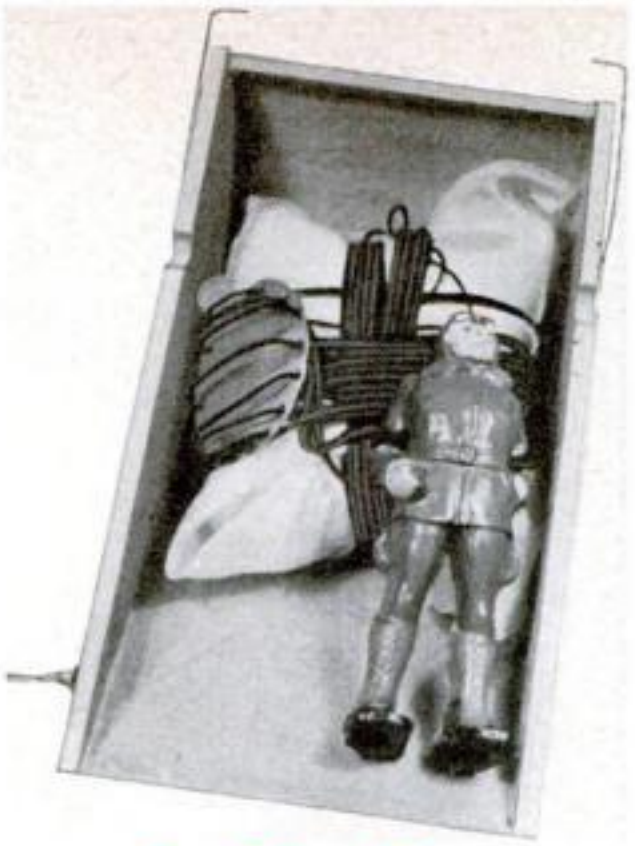
*Home workshops.* Is your lighting arranged so that individual lamps are located over each bench and machine, or do you light the shop with a high-wattage central unit? Where work is done in various parts of the room, individual lamps are more satisfactory and economical. Fluorescent lighting saves current and is excellent for close work. Have walls and ceiling painted a light color. Do not use motors larger than necessary; they take extra current. Electric glue pots may be wasteful of electricity if used much. When glue must be kept hot for long periods, a small gas plate is more economical.



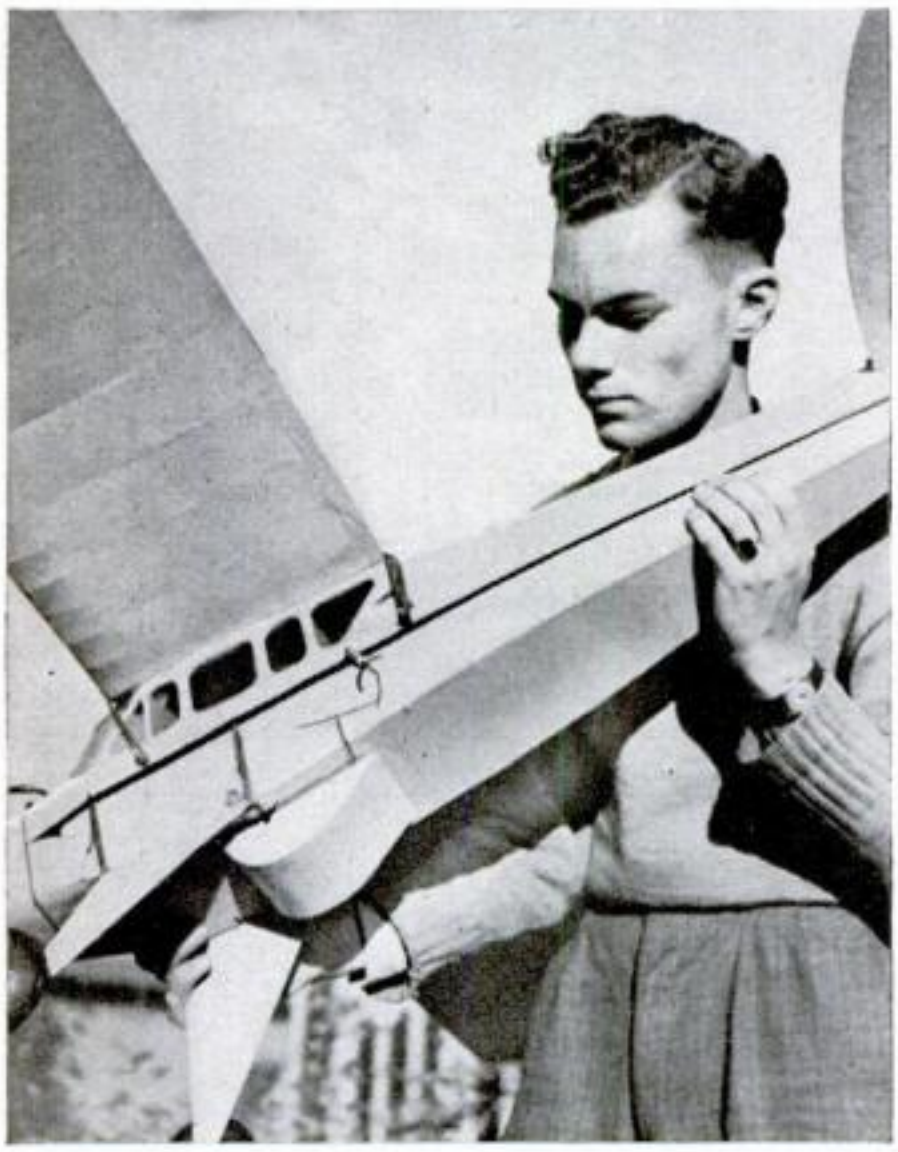

**Saving Electricity in the Home**

Small as may be the individual savings made by following these suggestions, they can effect real savings in your bill when multiplied throughout the home. And, when multiplied throughout the nation, they can and will contribute greatly to the conservation of a vital resource.

Paratrooper and 'chute packed in release ready for "bailing out"



# Parachute and Bomb Release



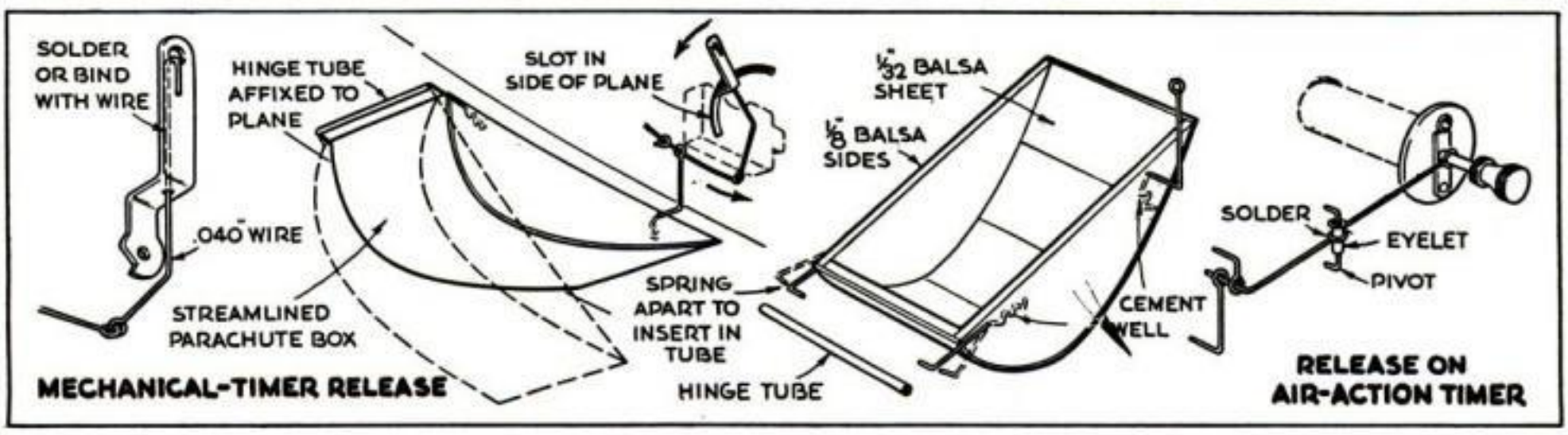
## ADDS THRILL TO MODEL PLANE

YOU can add extra action to the flight of any gas-powered model airplane by having a tiny parachutist "bail out" and float down while the plane is high in the air. The automatic release shown, which can also be used to drop miniature bombs, was designed by Charles Brennan, of Syracuse, N. Y. It can be installed even on finished models, and detached when not wanted.

No dimensions are given, as the size of the trap is governed by the amount of equipment it is to hold. Steel-wire hooks cemented to it engage a hinge tube fastened to the fuselage. They are sprung apart for insertion and removal.

The model at the left has a mechanical timer with an extended arm, to which a wire trip is attached. This type of timer cuts out the motor before the arm comes to rest, so the release can be made to operate after the motor stops. An air-action timer requires a special lever pivoted on an eyelet attached to the fuselage, as illustrated in the drawing below.

A silk parachute 3′ in diameter was used with the tiny figure shown. Soldier and parachute together weigh 2½ oz.—FRANK ZAIC.

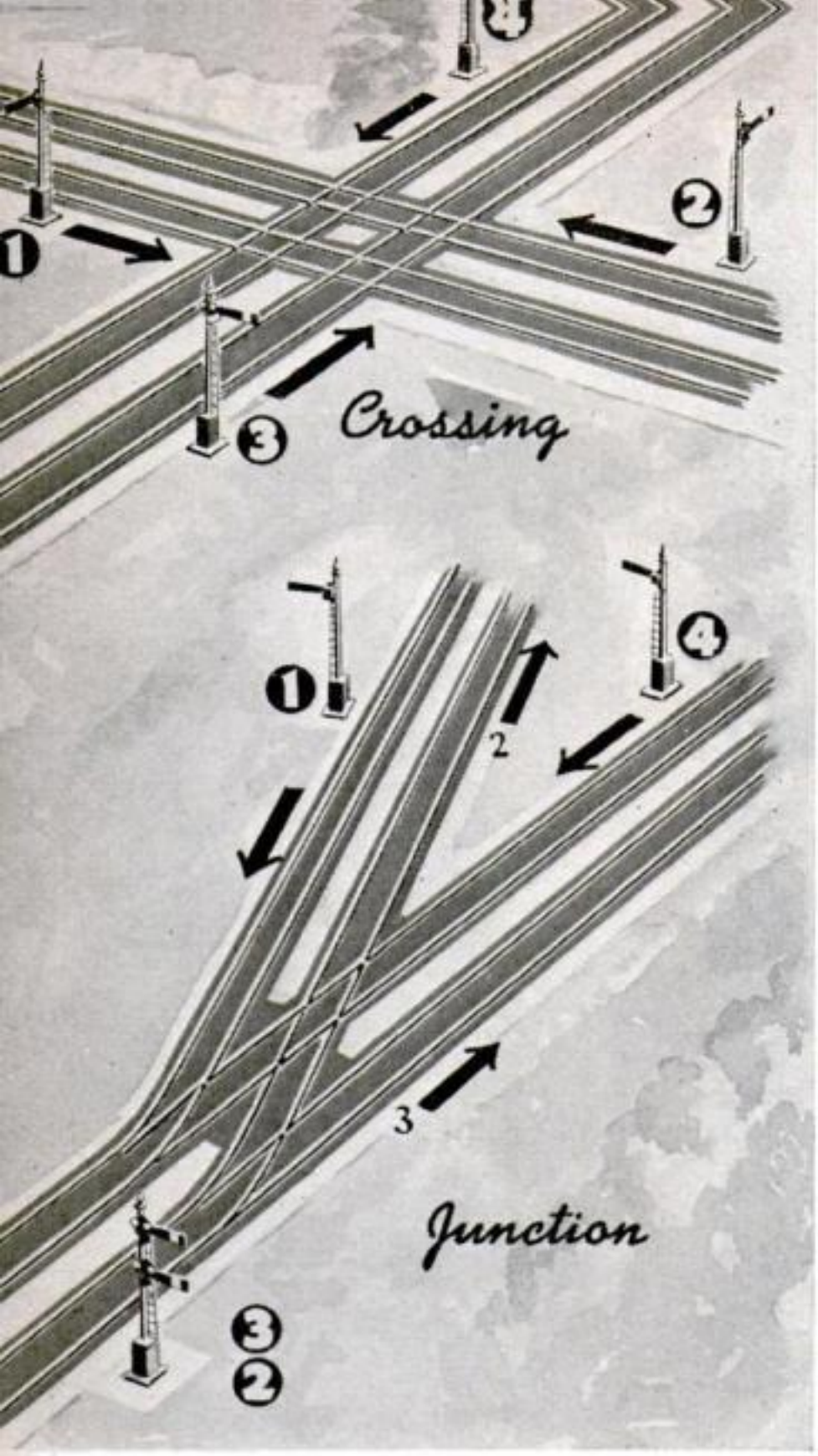


# Signaling a Junction

By DAVID MARSHALL

Author of *Model Railroad Engineering*

HOW to signal a double-track junction is one of the major problems of model railroading. It becomes easy, however, if we approach it by first signaling a four-track crossing, as we began to do when we combined four signals in one hookup, called an interlocking machine. This enabled us to *clear* at will any signal or either pair, but made it impossible to *clear* any two signals that fouled each other.




INTERLOCKING A JUNCTION presents the same problem as an intersection. Both the four-track crossing and the junction of the two diverging double-tracked routes here are protected by the same four signals, the difference being that for the junction No. 2 and No. 3 are on one mast

**MANUAL INTERLOCKER.** In Fig. 1, operating a four-track crossing, we simply open or close single-pole knife switches. Thus manually we (1) energize the relay of a given signal, causing that signal to go to the *clear,* or (2) break a circuit, allowing the signal to revert to its normal *stop* condition. On notice of a train's approach, the towerman closes the main lever, to the left or right, and throws the lever corresponding to the route he wishes to open. He cannot set up a conflicting route, except by throwing the main lever to the opposite side, which would cancel the first route.

**AUTOMATIC INTERLOCKING.** For all its virtues, the manual interlocker has one fatal weakness: the towerman can establish a route

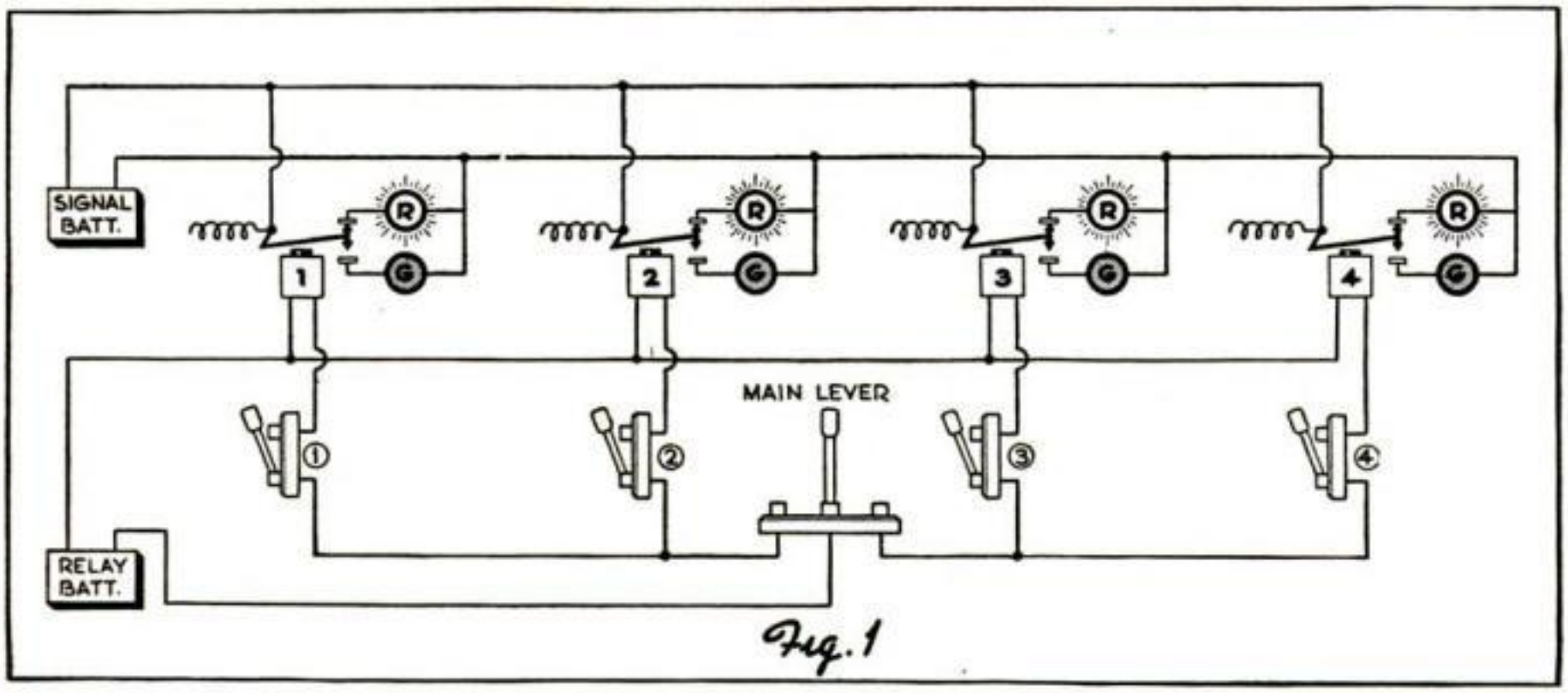



Fig. 1

that fouls one already occupied, for when a train enters an open route, he throws the signal to the *stop* in order to protect its rear, and the machine then cannot prevent him from setting up a conflicting route. To eliminate this chance for error, we may introduce track relays, transforming our machine into an automatic interlocker.

Relays and track circuits are the basis of automatic signaling. In Fig. 2, we have a main line broken into two blocks. From a track battery a current flows to the common rail, and through the train wheels and axles to the insulated control rail of an occupied block, through the track relay, and back to the battery. Thus the mere presence of a train in a block causes a normally *clear* signal—the usual thing in block signaling, as distinct from interlocking work—to go to the *stop*.

Returning to our crossover, we insulate our four routes from one another and from the crossing frogs, and equip each with two relays, connected in parallel so that both act in unison. These relays, on being energized, do not necessarily alter the condition of any signal; they simply break circuits which may or may not be broken already.

In Fig. 3, all eight relays are inserted between the main lever and the four signal levers. The relays operate in pairs, as numbered, entirely in response to train movements; the towerman has no control over them. They have simply been added to the machine shown in Fig. 1. Figure 3 shows the same machine but with the signal circuits and the wiring that connects the relays and tracks omitted.

On an automatic machine, the towerman establishes routes as before. But let him now set up the No. 2 route. The main lever goes to the left, the No. 2 lever is closed, the No. 2 signal flashes green. When the train enters the route, both No. 2 track relays are energized, and the No. 2 signal falls back to the *stop* automatically, providing rear-end protection. Simultaneously the circuit is broken between the main lever and the No. 3 and No. 4 signal levers, so that as long as the train remains upon the No. 2 route, these signals remain at the *stop*. Yet the towerman is free to *clear* the No. 1 signal, for its route and the No. 2 route are acceptable to each other.

**JUNCTION INTERLOCKER.** At the upper left on the facing page, we have the four-track crossing protected by the four signals we have just finished interlocking. Below this, we have the junction of two diverging double-tracked routes, protected by the same four signals. The only difference is that the No. 2 and No. 3 signals are both set upon the same mast, the No. 3 above because the rule is that the through route is high, the diverging route low. Only remember that you still have two separately operated signals here.

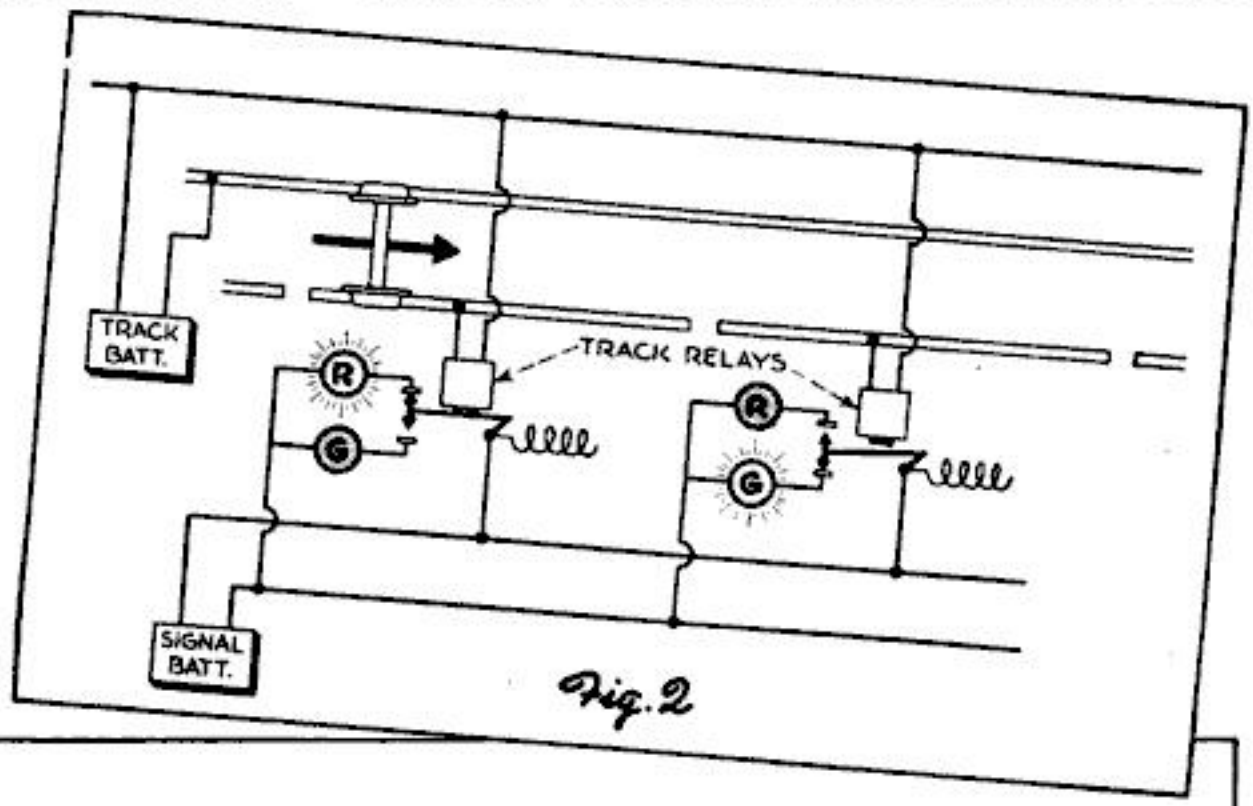


Fig. 2

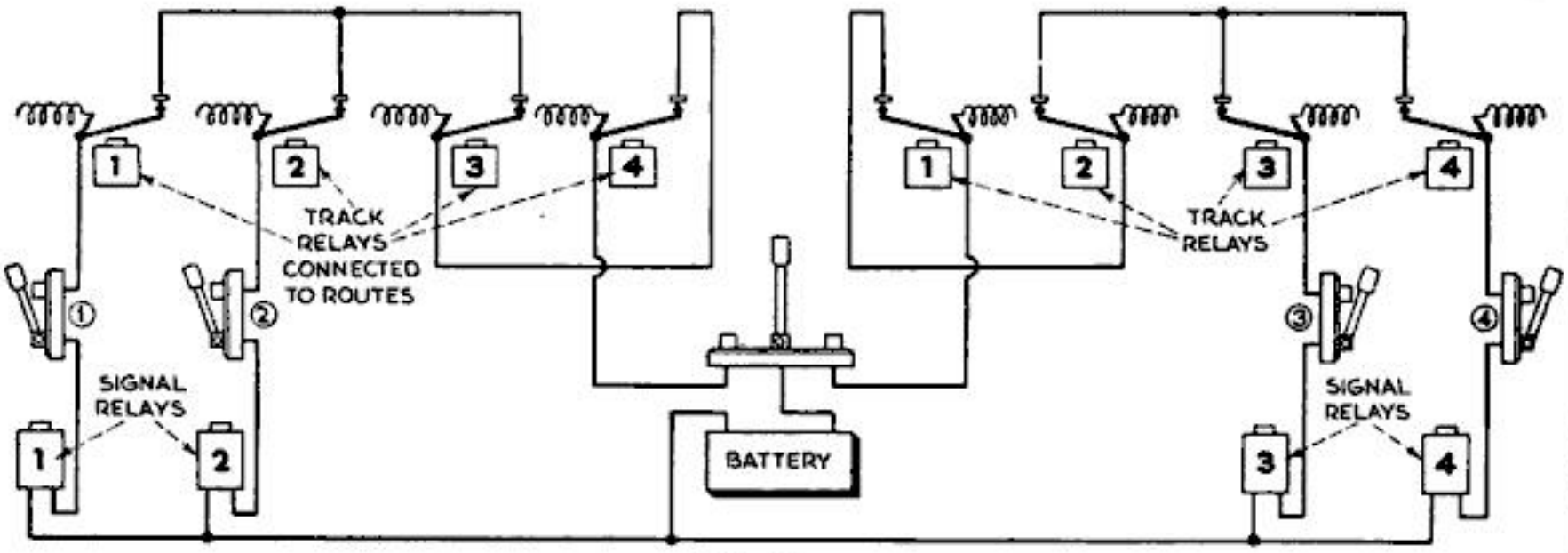
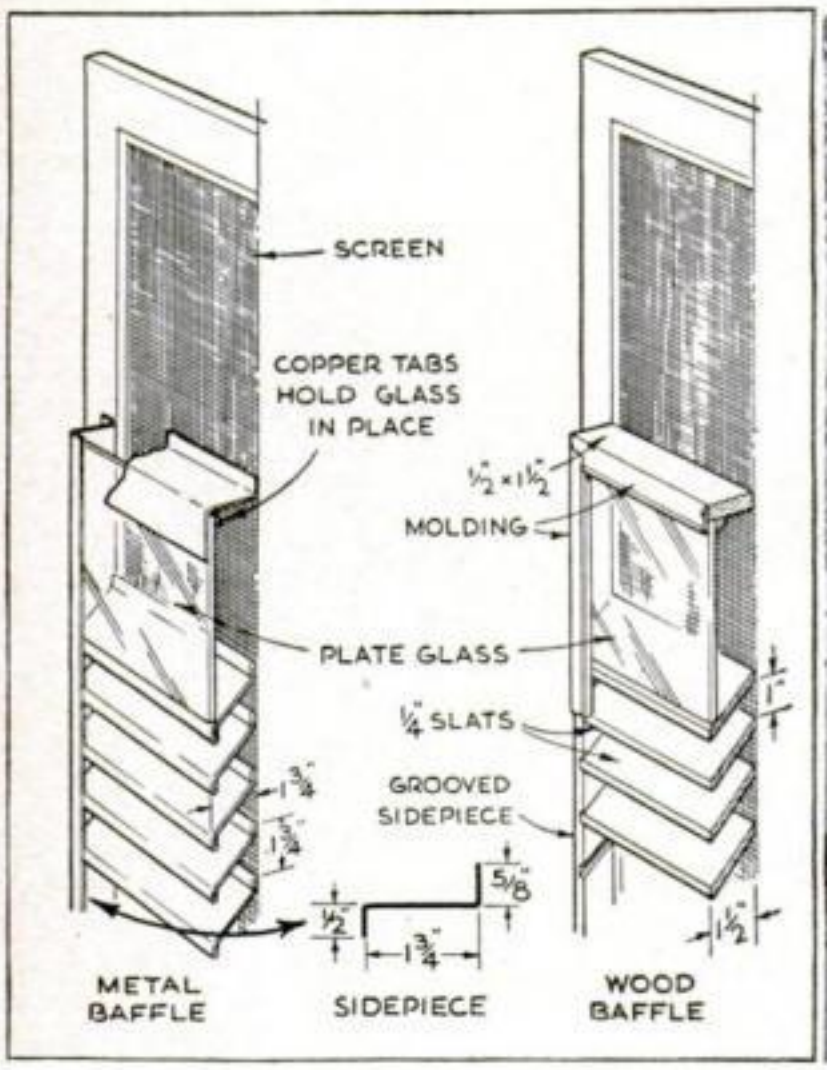


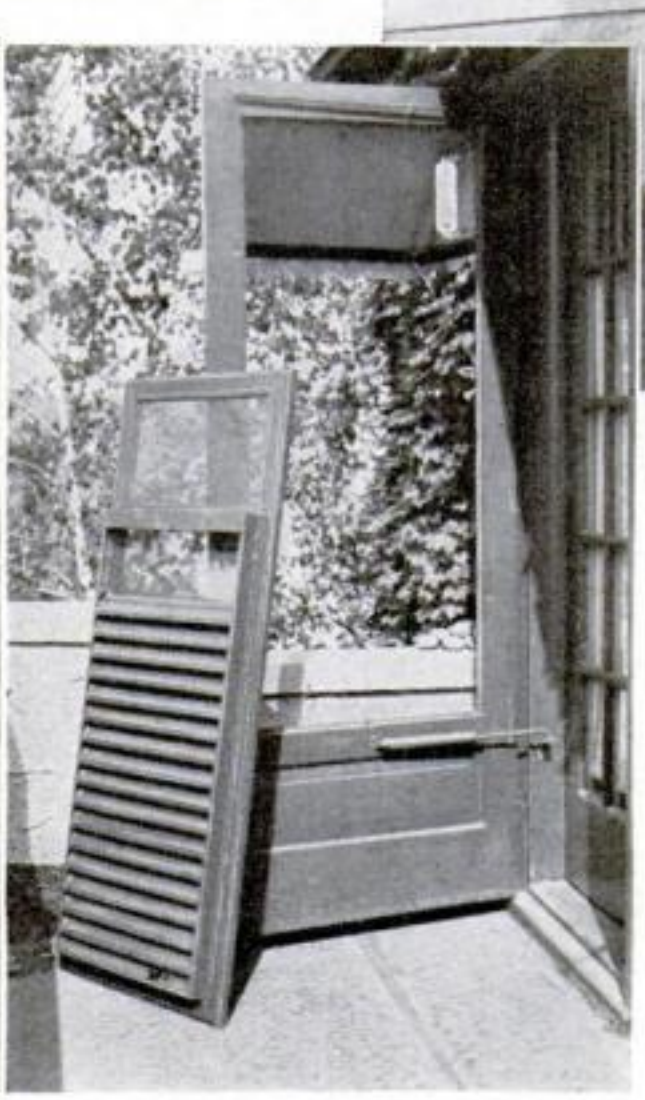
Fig. 3

# Screen Doors Made Rainproof by Adding Baffles of Sheet Metal or Wood

YOU needn't get up to shut an outside door when a sudden shower occurs during the night, nor swelter in warm rainy weather, if you fit the screen door with baffles like those illustrated in the accompanying photographs. Windows, too, whether screened or not, can be equipped in this way to afford ventilation at all times.

Although this particular unit was made to order by a tinsmith, an equally good one can be built of wood by the method shown in the right-hand drawing below. The sidepieces are dadoed or grooved to receive the slats. If made of sheet metal, the parts are riveted together, and the glass is held in by tabs bent against it. Give the baffle three coats of a good outdoor paint.—A. J. VIKEN.



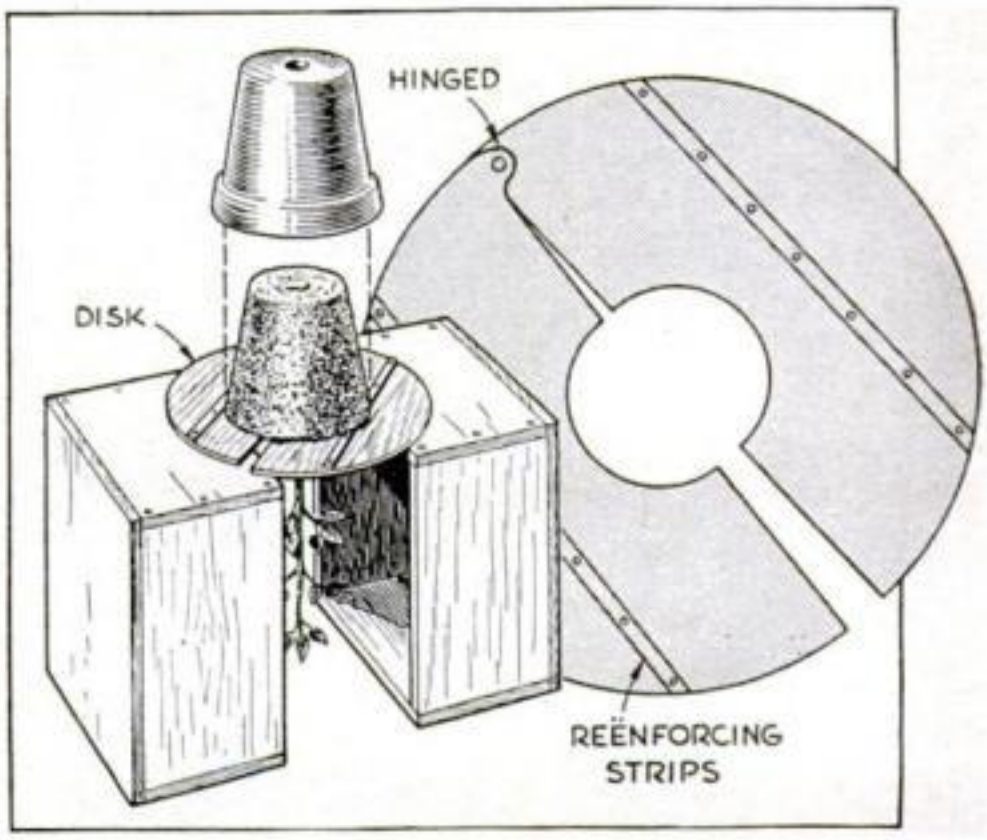



Screen door with metal baffle. Note the glass window above the baffle, and the awning, which is attached to the door itself

Baffle and window form a removable unit, which is constructed as in the drawings at left

# Disk Aids in Transplanting from Large Flowerpots

THE difficulty of transplanting from a large pot or tin can may be reduced by making a two-piece circular support from plywood or sheet metal, as shown. The halves are reinforced, if necessary, with wooden slats. Before attempting to remove a plant, loosen the soil from the sides of the container. Place the disk around the plant, invert the whole, and rest the support on two boxes or chairs so that the plant will clear the ground. The container can then be lifted off, leaving the soil and roots intact. Plants so handled readily survive transplanting.—CHARLES H. HARDY.



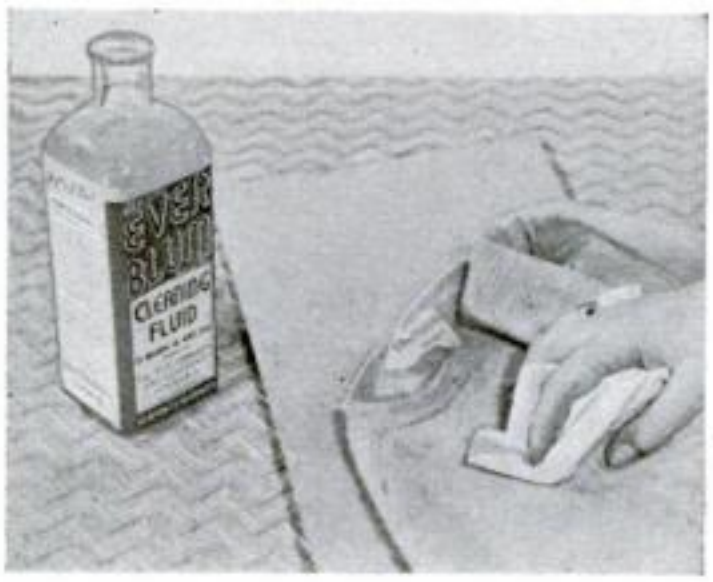

HW 112

# NEW APPLIANCES to aid in *Housekeeping*

THIS NEW ELECTRIC ROASTER, large enough for cooking a 20-lb. turkey, is equipped with a broiler and griddle consisting of a heating unit, hinged reflector, smokeless inset tray, and drip pan. The broiler attachment can be used without removing pans from the main cooking well, so that a full-course dinner may be prepared at one time. An extra shelf makes possible the baking of pies or cakes on two levels. Insulation is blanket-type glass wool 1" thick

BARBECUING IN A BARREL adds to the gaiety of informal parties, and with this barrel, which is aged with wine, tasty dishes can be prepared. This novel "stove" uses charcoal or hardwood chips as fuel, won't smoke, can't get too hot to touch, and may be used as safely indoors as out

REMOVING SPOTS from clothing without leaving a ring is possible with this new cleaning fluid. A cloth on a piece of cardboard placed under the soiled area, as below, will absorb the grease as the fluid is rubbed through. Best results are obtained by working with the weave

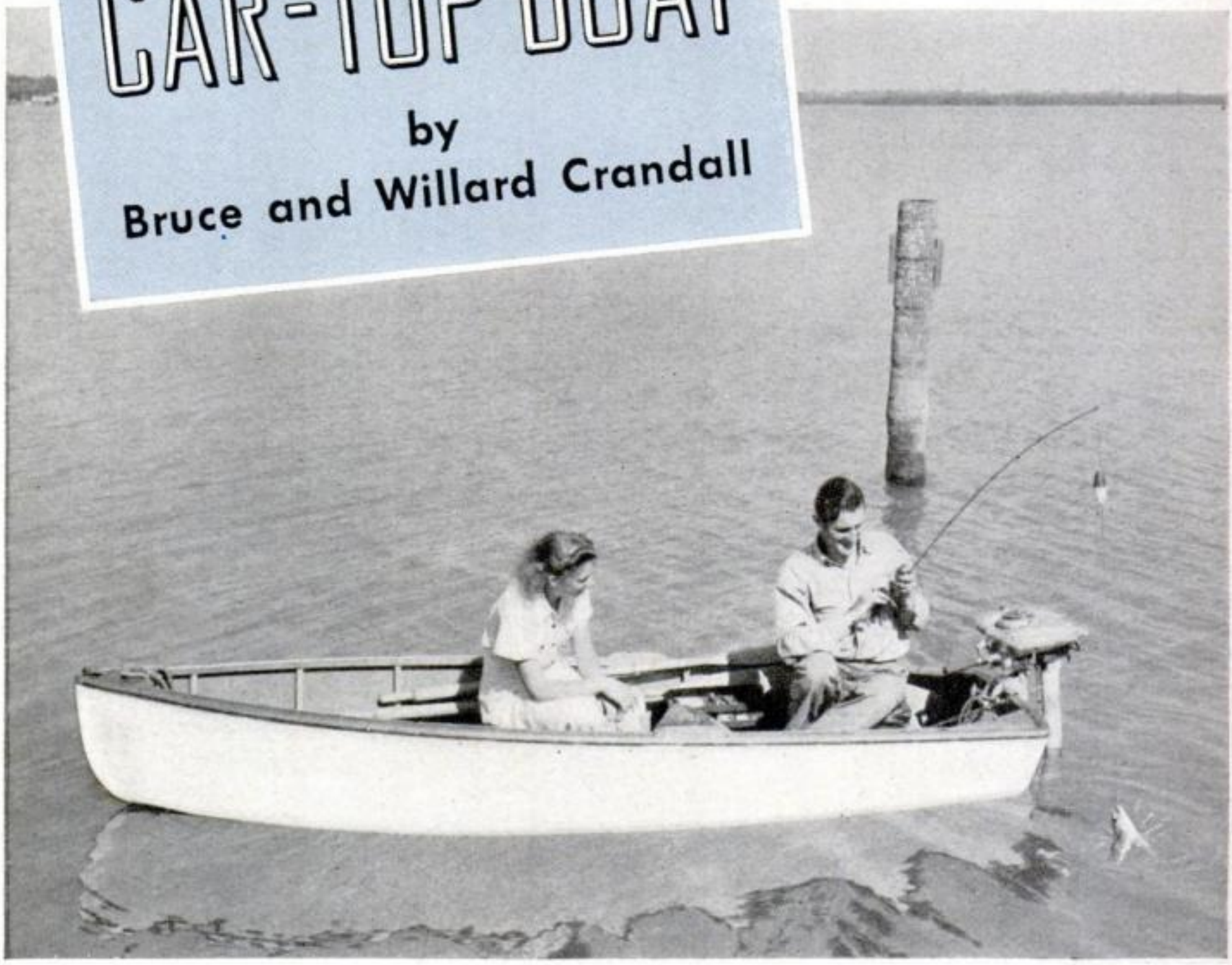


PART II

# CAR-TOP BOAT

by

Bruce and Willard Crandall



IF YOU are building our new lightweight boat *Tops* and have constructed the frame as described in the first installment, you are ready to begin the planking. For this, waterproof marine plywood either ⅛" or ¼" thick is used.

The shape of the side planking may be determined by clamping or holding in place a 12' long sheet of plywood over the framework and then marking the shape on the panel. After the piece for one side has been sawed out, it should be tried on the other side, and if it fits there well enough, as it should, it can then be used as a pattern for that side plank.

Before the plywood is fastened in place, the joining surfaces of chines, stem, and transom should be coated with marine glue. It will be best to fasten both sides in place at the same time, so as not to pull the boat slightly out of shape.

The side planking is fastened with flathead screws as follows: (1) Into chines, ⅞" No. 7, spaced about 2" apart; (2) into transom framework, a double row of 1¼" No. 7, spaced about 1½" apart; (3) into stem, 1¼" No. 7, spaced 1" apart; (4) into frames, 1¼" No. 7, spaced about 3" apart.

The holes for the screws should be countersunk only very slightly, if at all, as the heads should be flush with the outside of the planking and there should be compressed wood under each screw head. It is not necessary to fasten the planking to the sheer battens until the half-round gunwales are in position.

After the side planks are in place, they are dressed down flush with the chines so that the bottom planking will fit perfectly. The keel can now be cut out of the wood selected—spruce, mahogany, oak, fir, cedar, cypress, pine, or redwood being suitable in that order of preference, as noted in the list of materials accompanying the first installment—and tried in position to mark off the keelson bevel. Cut the keel to fit the shape

With the keel cut to shape and clamped in place on the keelson, mark along the edge to indicate the extent of the keelson bevel. The keel is cut to fit the keelson aft and bent to shape forward

of the keelson from the transom to frame No. 4, as shown in the drawings in the earlier installment. Forward of this frame, the keel is bent into position. It is then fastened through the keelson to the frames with 2½" No. 12 screws, and to the keelson, between frames, with smaller screws. It must also be fastened from the inside after the boat is off the form and before the transom knee is in place.

It is important to cut the limber holes in each frame, next to the keelson, before the bottom is put on. The two pieces of plywood for the bottom will lap over the side planking. These two bottom pieces should be cut to approximate shape and, before proceeding further, made to fit perfectly against the keel. Then the surfaces of the chines, transom, keelson, and other parts are coated with marine glue and the bottom is fastened in place in the same manner as the sides, except that 1¼" No. 7 screws are used for fastening into the chines, and ⅞" No. 7 screws, spaced about 2" apart, at the keelson (or shorter screws if the keelson is less than ¾" thick). If ⅛" plywood is used for planking, ¾" screws should be substituted for ⅞" throughout.

The planking is next carefully planed flush all around, and the side planking is dressed down at the bow so that the outside stem will fit over it. This joint should be made watertight with a strip of cloth soaked in

To insure a watertight boat, the entire bottom surface of the frame must be faired and beveled accurately before the plywood planking is put in place. Here the plywood has been cut roughly to shape at the edges and is being fitted carefully against the keel. This operation must be exact. Next, the bottom surfaces of the chines, transom, keelson, and other parts are coated with marine glue, and the planking is fastened on with screws

marine glue, and the outside stem screwed to the inner stem with 2½" No. 12 screws. The outside stem is then cut to a bevel, leaving just the ½" base to which the stem band will be fastened.

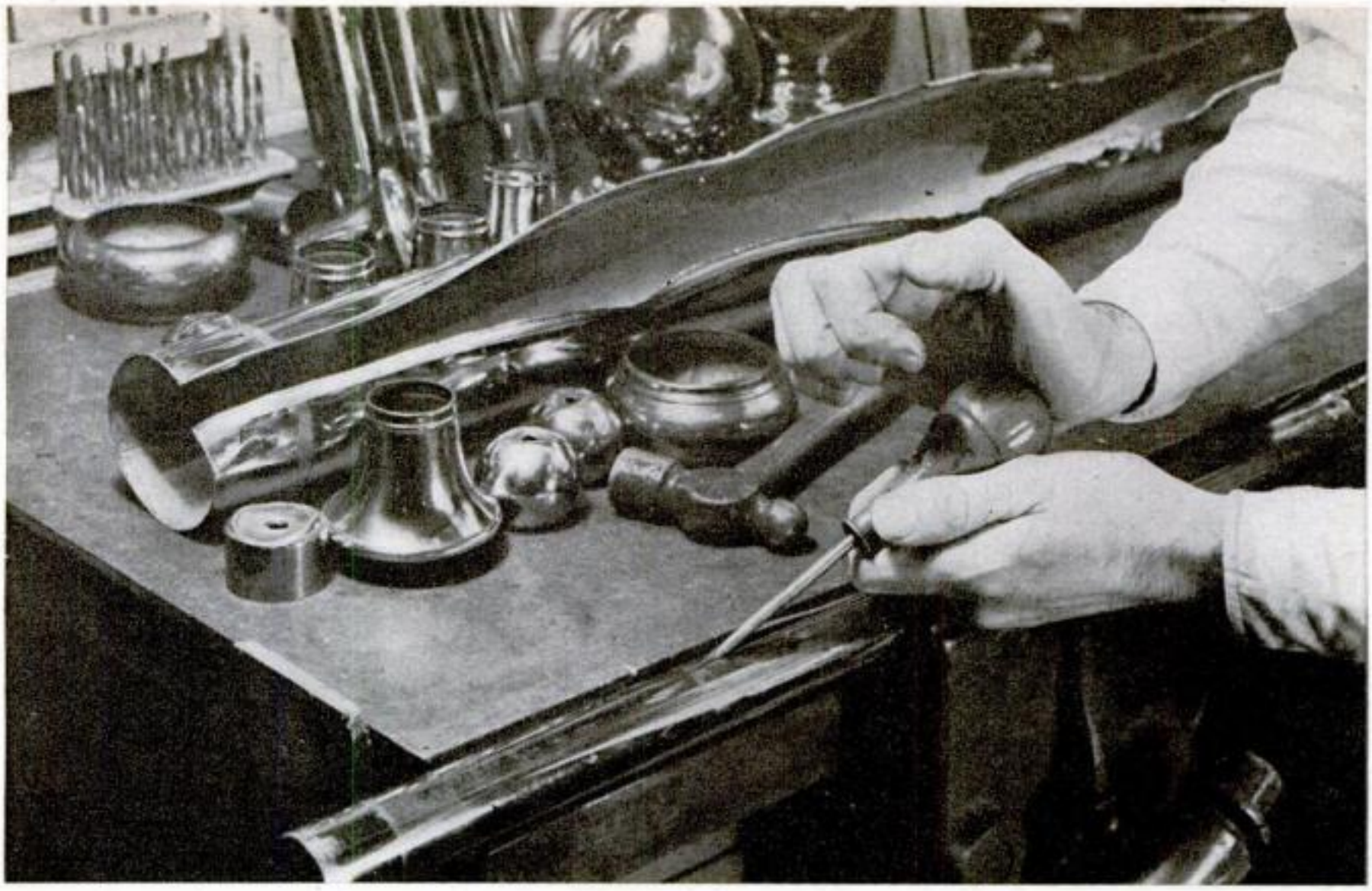
The boat can now be turned right side up. After the sheer has been planed to a fair curve, the half-round gunwales are clamped in position and fastened from inside and outside with ⅞" No. 7 screws. Next, the inwales are notched slightly into the side frames, and the breasthook, oarlocks, and transom knees are installed as shown in the drawings. The transom knees should be well fastened with 2½" No. 12 and 2" No. 10 screws. The entire inside is then painted before work is started on the seats, floor boards, and remaining details.

The seats and floor boards can all be made from left-over plywood. If ⅛" plywood is used for floor boards, slats will be needed underneath to provide sufficient strength. All plywood should be primed with resin primer, special care being taken to seal the exposed edges. The hull may then be finished with marine paint and spar varnish, as desired.

A half-round strip of hardwood can be added to protect the edges of the plywood along the chine, while rub strips on the bottom may be necessary if the boat is to be pulled up often on a rough beach.

Up to the point illustrated at left, all work was done on our boat while it was upside down. Here, however, it is righted and the sheer is being planed to a fair curve. The inwales have already been installed, notched slightly into the side frames. Next, the breasthook, oarlocks, and transom knees are fastened in place, care being taken to screw them on securely

When the seat framework is completed and in place, the entire inside is painted, after which the floor boards can be laid and the seats attached. For both these parts, left-over plywood is suitable. If the stock used for the flooring is only ⅛" thick, slats should be provided underneath or there will not be sufficient strength. These operations wind up the building, and you have a light, portable, general-utility boat ready for the finishing coats of marine paint and spar varnish of your own selection



## Discarded Old-Style Bed Is Worth Its Weight in Brass

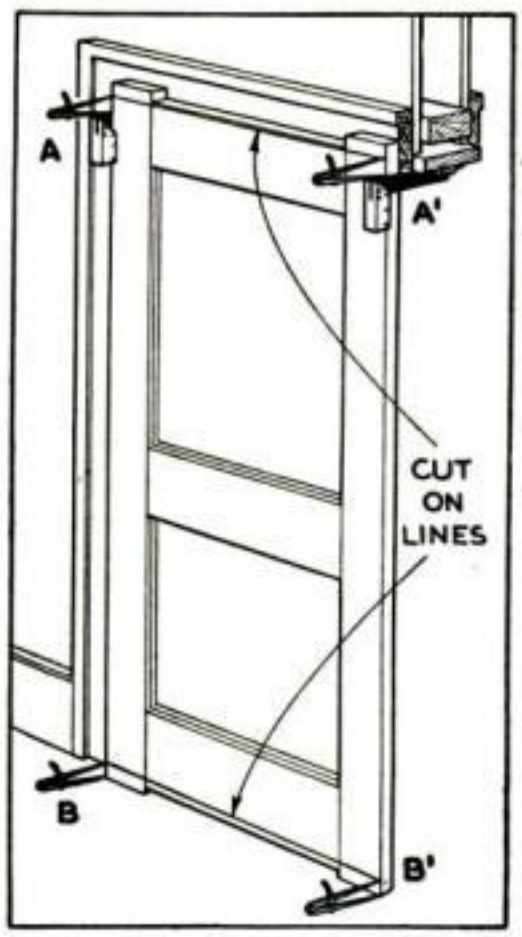
AN OLD brass bed, properly disassembled, will provide a surprising quantity of materials useful in the home workshop or even in a small shop engaged in production. One often will yield 10 lbs. of brass, much of it in sheets that covered steel tubes.

Here is the result of a salvage operation on a double brass bed of the vintage of the first World War: 12 sq. ft. of .005″ sheet brass; 12 sq. ft. of .010″ sheet brass; almost 4 lbs. of brass knobs and trim; 28′ of 1¼″ steel tube; 8½′ of 1½″ steel tube; 19′ of 2½″ steel tube; 8′ of 1¼″ by 1¼″ angle iron; 11½′ of 1½″ by 1½″ angle iron, and miscellaneous brass and iron bolts, iron wedges, and the like.

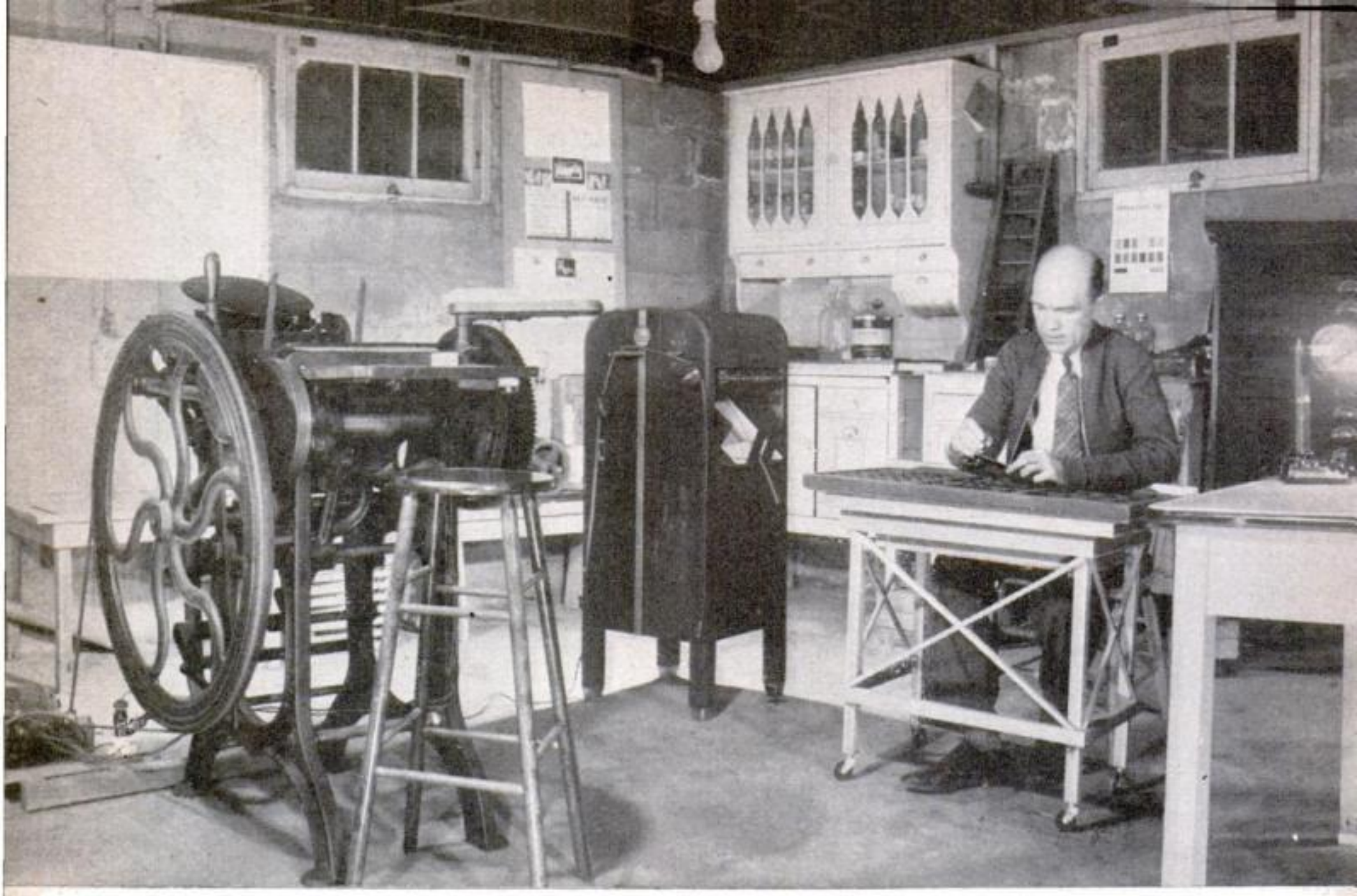
The steel tubing has an open seam that is easily tacked or closed by brazing or welding. Such tubing is excellent for making welded workbench frames or stands for shop machines. The angle iron, of a hardened type best cut with a torch or an abrasive wheel, can be used for an endless variety of purposes. Sheet brass unwrapped from the tubular parts is rather stiff and springy and can be employed for making small flat springs, or it can be annealed by heating and used for decorative purposes in craftwork. The brass knobs can be melted down for making castings.—WALTER E. BURTON.

## New Door Scribed for a Correct Fit with Try-Square and Dividers

SCRIBING a new door for height so that its top and bottom edges will conform to the shape of the frame, regardless of how far the frame is out of square, can be done with the aid of a try-square and dividers. To scribe the top, hold the square firmly against the stop-bead molding on the door jamb, first at one side and then at the other, and set the dividers to the depth of the rabbet as shown at *A* and *A′*. To scribe the bottom, set the dividers for the total clearance that is desired, as at *B* and *B′* in the drawing.—J. MODROCH.




Cut-away section of the door frame at right shows how a square and dividers are used to scribe a door



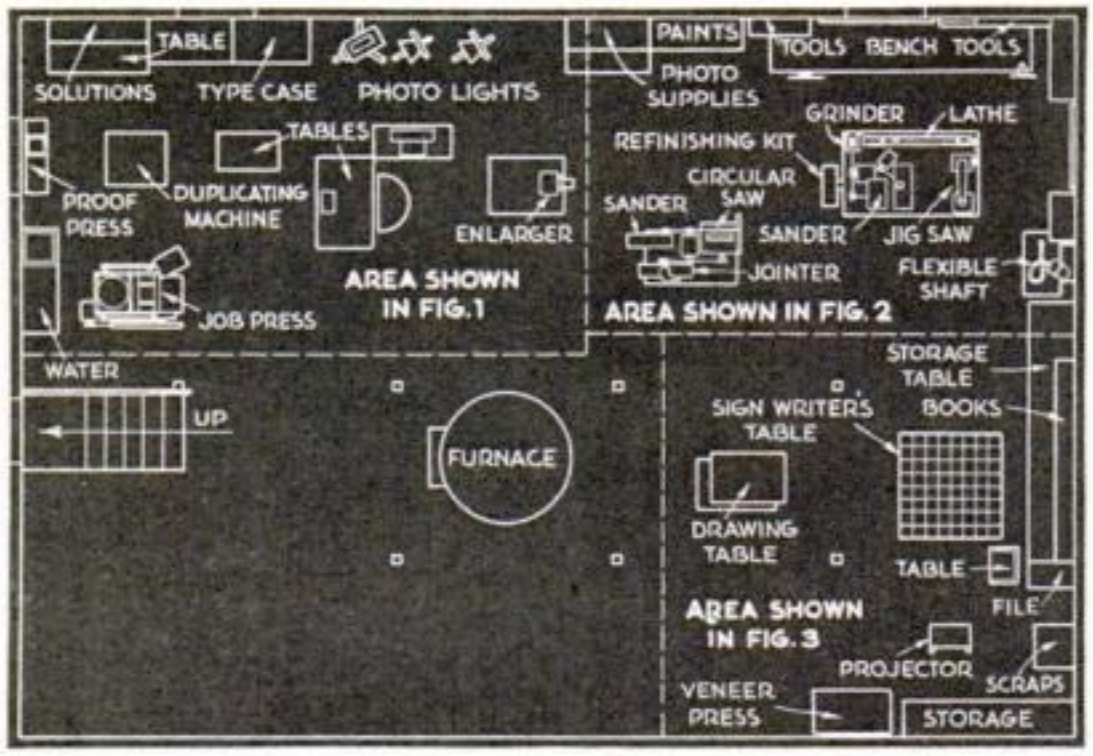
# Workshop of a Man with Many

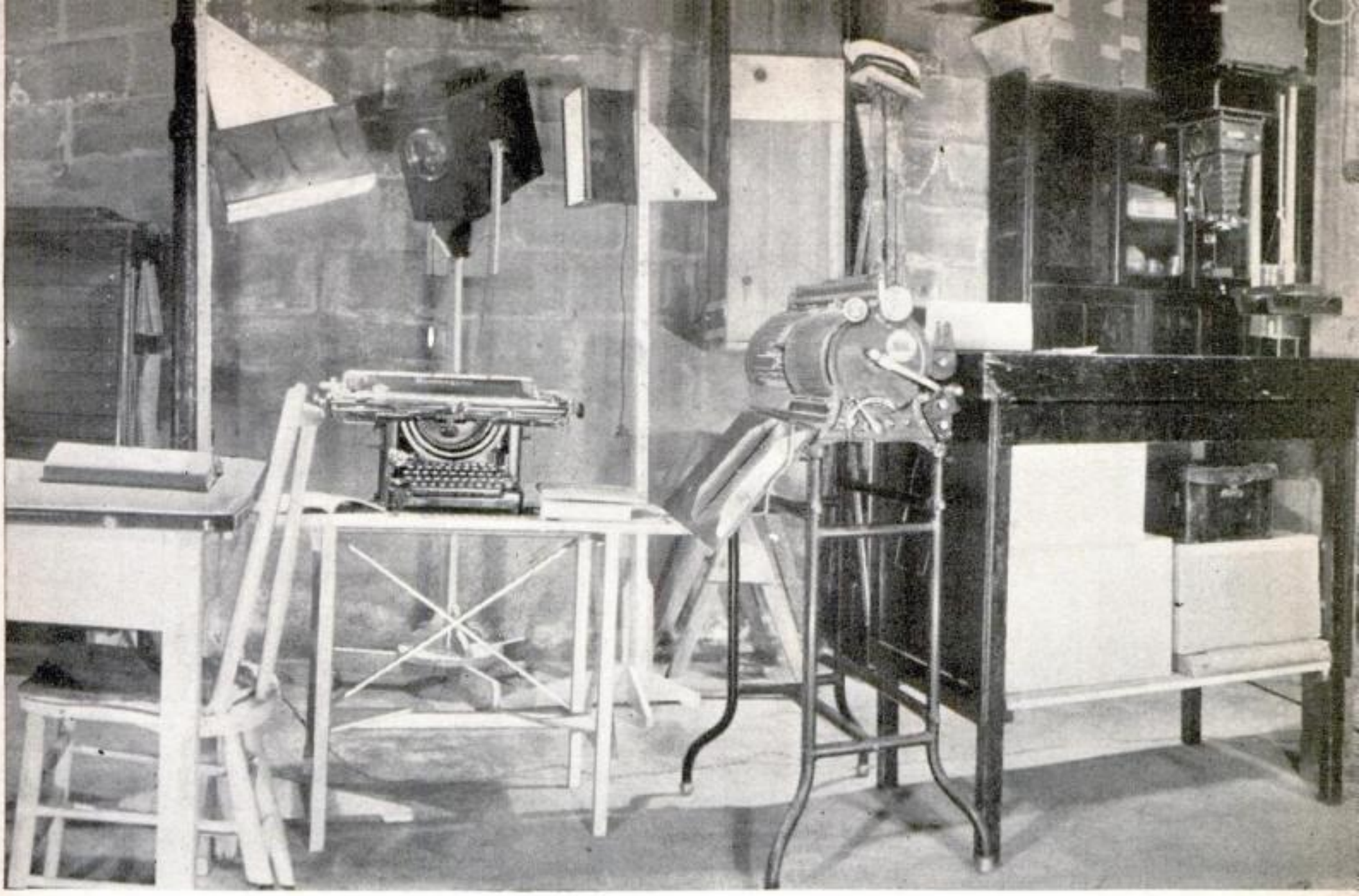
IT WOULD be hard to classify the home workshop of Louis A. Lembach, of Lexington, Neb., for it is really five shops in one. In it he builds furniture and craftwork novelties and does job printing, high-speed duplicating work, sign painting and other commercial art work, and photography. Yet this remarkable shop had its beginning only seven years ago in a small lathe and a jig saw obtained as premiums for coupons.

Today it occupies the greater part of a 28′ by 48′ basement and includes a comprehensive assortment of machine and hand tools, every piece purchased on the principle that it must pay for itself before another is added.

The shop is L-shaped, and divided into four parts to save steps and use space to full advantage. That part devoted to commercial art has two specially designed, homemade drawing tables, one with a 2′ by 3′ board and the other with one 4′ by 4′, adapted to showcard and sign writing. A projector facilitates copying or enlarging art work. Supplies are in drawers and shelves in the tables and a built-in closet.

In the woodworking section are a long workbench and two machine-tool benches. A circular saw, a jointer, and a belt sander, all driven by one motor, are mounted on one of these. The other has a lathe, a jig saw, two sanders, and a grinder. Under these is an air compressor. Drawers and wall cabinets accommo-



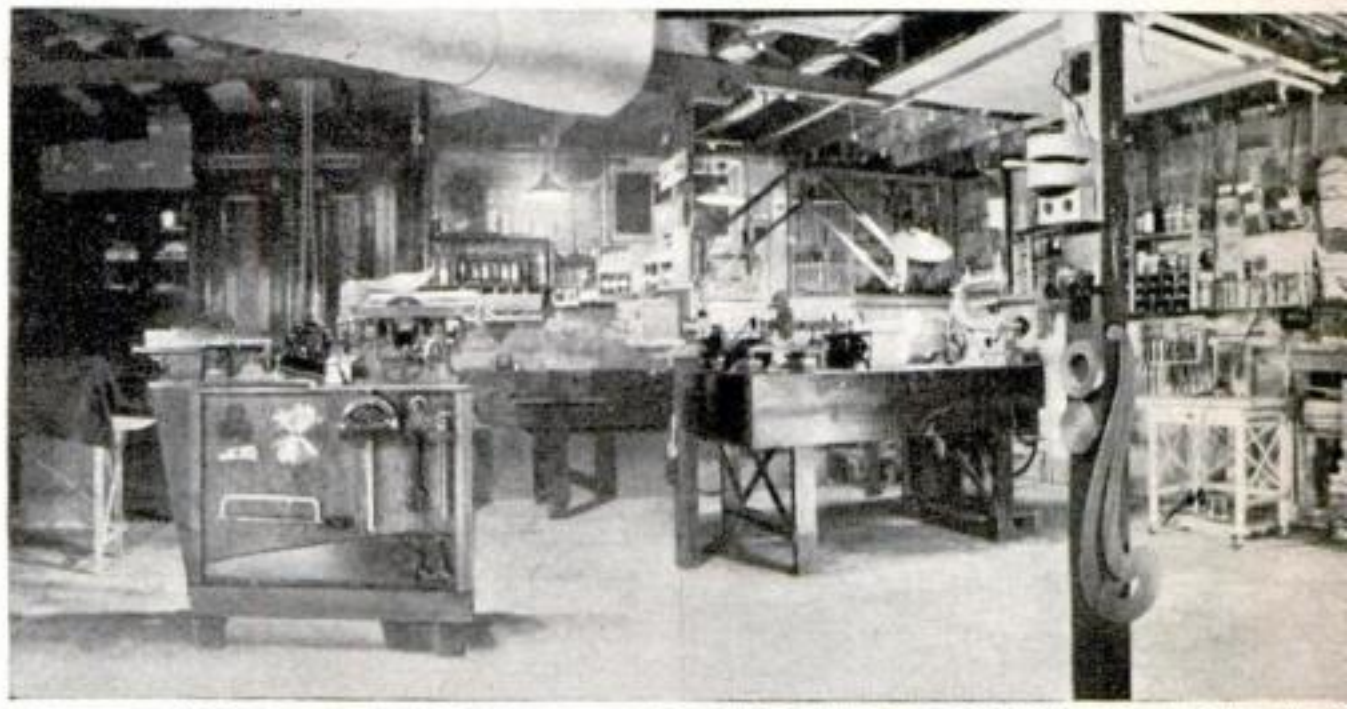


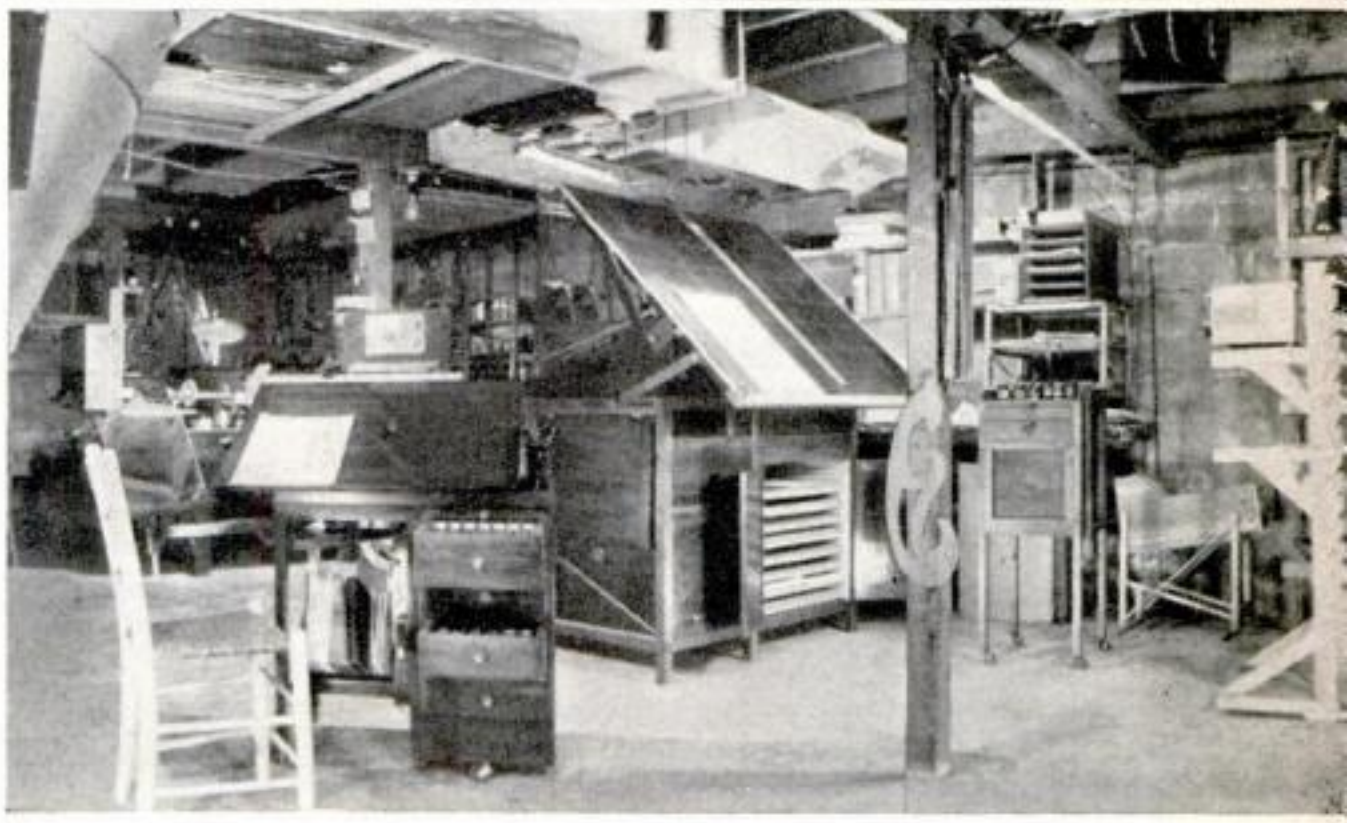
# Hobbies

date small tools and supplies. Paints, varnishes, and other refinishing materials are kept in a portable, two-part rack attached to a post.

Special blinds for the windows adapt the shop for use as a photographic darkroom. The table on which the enlarger is mounted has shelf space supplementing a nearby wall cabinet. The illustrations are products of Lembach's photography, and each consists of several shots to give a panoramic effect. The one at top, in which he himself appears, is made up of five photos.

A 7″ by 11″ printing press, a proof press, type cabinets, and a small rotary duplicating press round out the equipment. Lembach has already turned out a considerable amount of job printing and duplicating with these, the newest additions to his shop.





## BATTERIES POWER COMPACT

# EMERGENCY RECEIVER

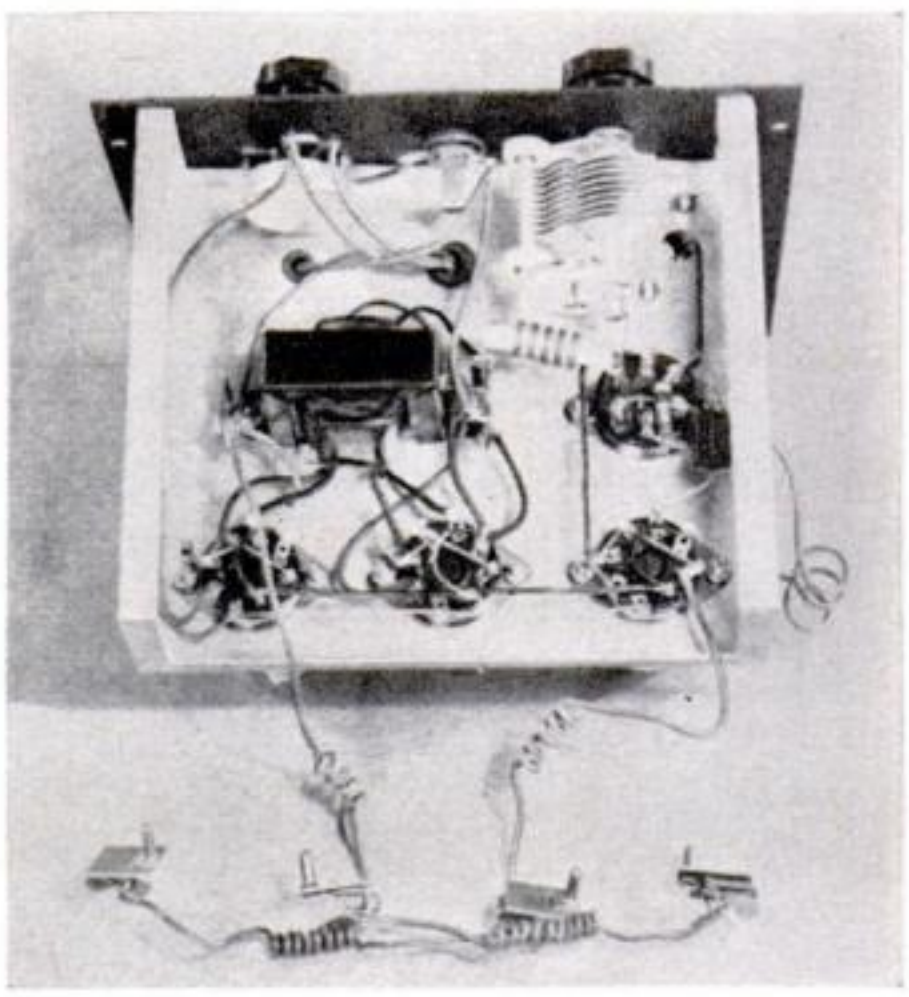
This portable set, designed for defense organizations, picks up near-by broadcasts without the use of a ground

DESIGNED to meet the requirements of defense organizations, this is a portable emergency short-wave receiver that eliminates the use of bulky "B" batteries without sacrificing power, quality, selectivity, or sensitivity. Instead of the usual 90- to 135-volt "B" batteries, the metal carrying case comfortably encloses, in addition to the usual "A" battery, two small "C" batteries which reduce the plate voltage to eight or nine and cut the filament voltage in half. Since the "emission life" of a tube is greatly lengthened when operating at a reduced voltage, the life of the tubes in this novel receiver may be at least doubled.

The new single-ended, all-metal 6.3-volt AC-DC tubes (6SJ7) or the single-ended glass type 1½-volt battery tubes (1SA6GT) can be interchanged in the set without any rewiring. The choice of either tube depends on whether you want a husky tube that will take more abuse in the field or a tube that will conserve the batteries to their limit. The metal tubes consume more electricity, but they are more robust for portable use and are slightly more sensitive. The glass tubes conserve electricity, but they are not so serviceable in the field.

Filament voltages are extremely critical in both types of tubes and any variation—even as little as 1/10 of a volt—will reduce the power of the receiver. In fact, if the tubes are

Tubes shown here are the new all-metal, 6.3-volt 6SJ7 type, but battery 1SA6GT tubes will serve



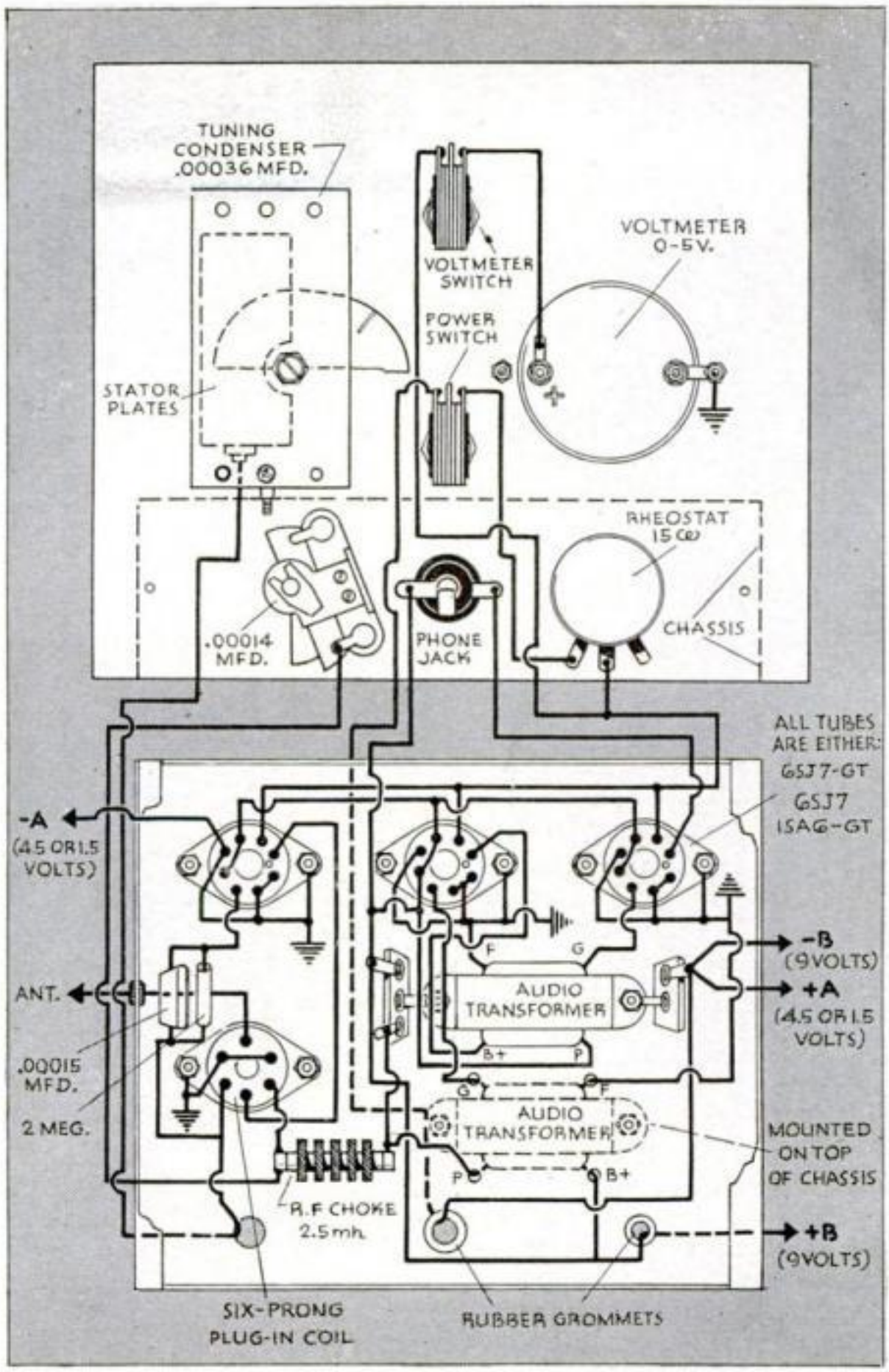
View of the receiver chassis from the underside, showing the wiring and connection to phone clips

By
**ARTHUR C. MILLER**

operated at their normal voltages, the set will stop functioning. For this reason a voltmeter is placed on the front panel for a visual indication of the "A" batteries' current. The knob directly under the voltmeter operates a 10- to 15-ohm rheostat which controls the filament supply.

But for special tube connections, the set is built with a standard detector plus two audio-frequency amplifying stages. Interstage coupling is achieved by means of two unshielded 1:3 audio transformers, one mounted above the chassis and one below. The output of the receiver is fed directly into a pair of magnetic 2,000- to 4,000-ohm headphones. These phones can be plugged into the front of the panel.

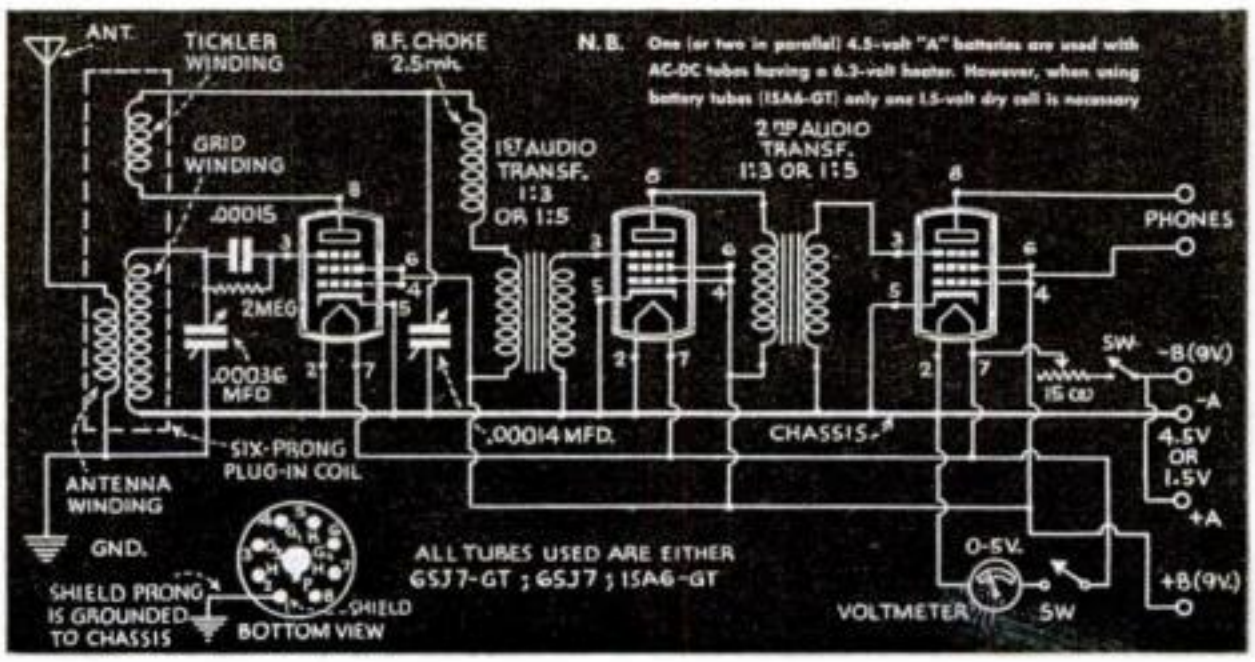
Plug-in coils enable an operator to tune in on various wave bands ranging from 16 to 1,000 meters. This includes ship-to-shore, broadcast, aviation, police, foreign, and domestic transmission. If



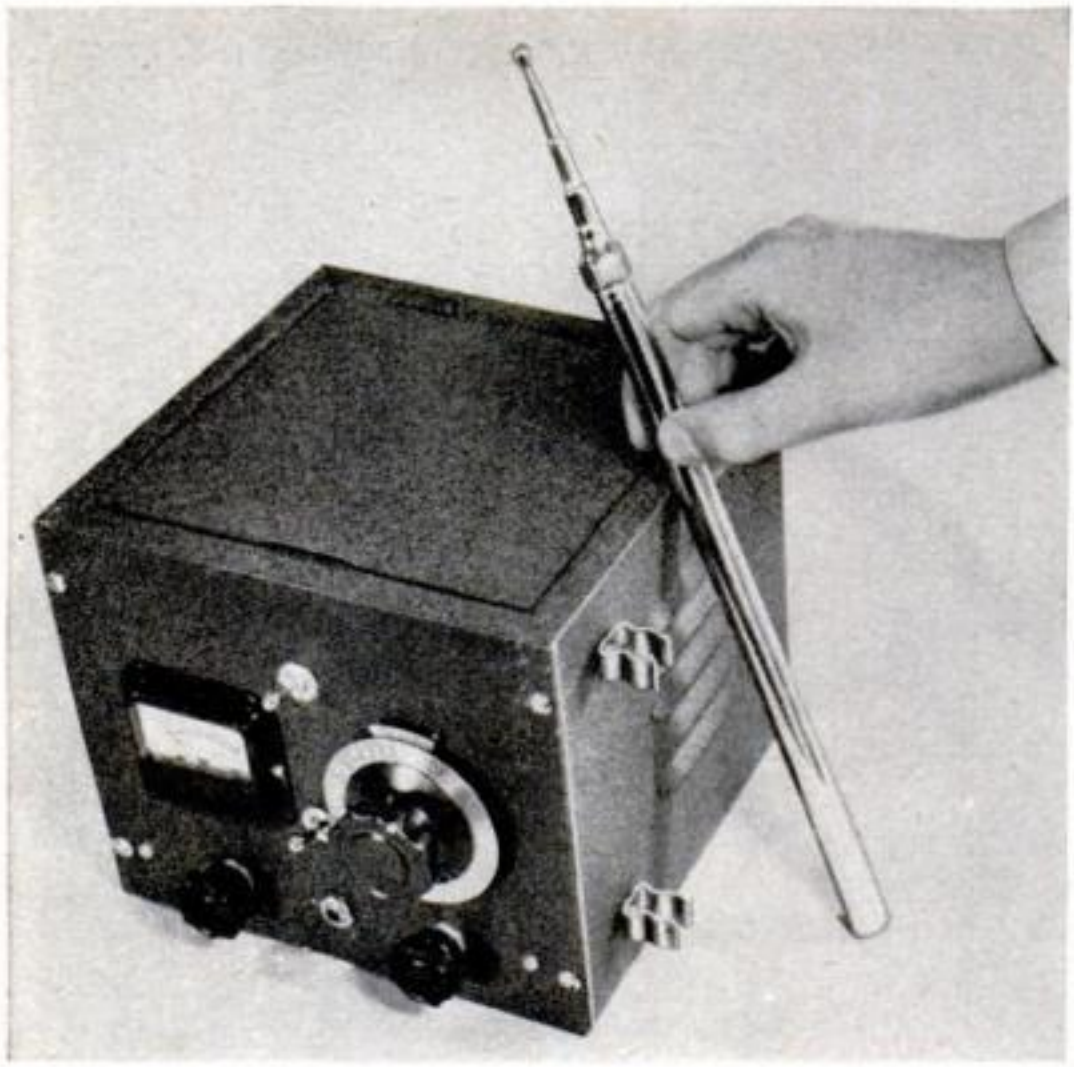

Two midget "C" batteries with low voltage replace the bulky "B" battery, lengthening the "emission life" of the tubes

Pictorial diagram of the compact, portable emergency receiver. This shows in detail the placing of the parts both on the chassis and on the front panel. In making the connections, solder should be used

Below is a complete wiring diagram in simplified form to be followed in making connections. A tickler-winding coil is used in the antenna




HW 121



Clips on the cabinet next to the tuning condenser hold the telescopic, metal antenna when the radio is in operation. These clips must be fully insulated from the metal cabinet

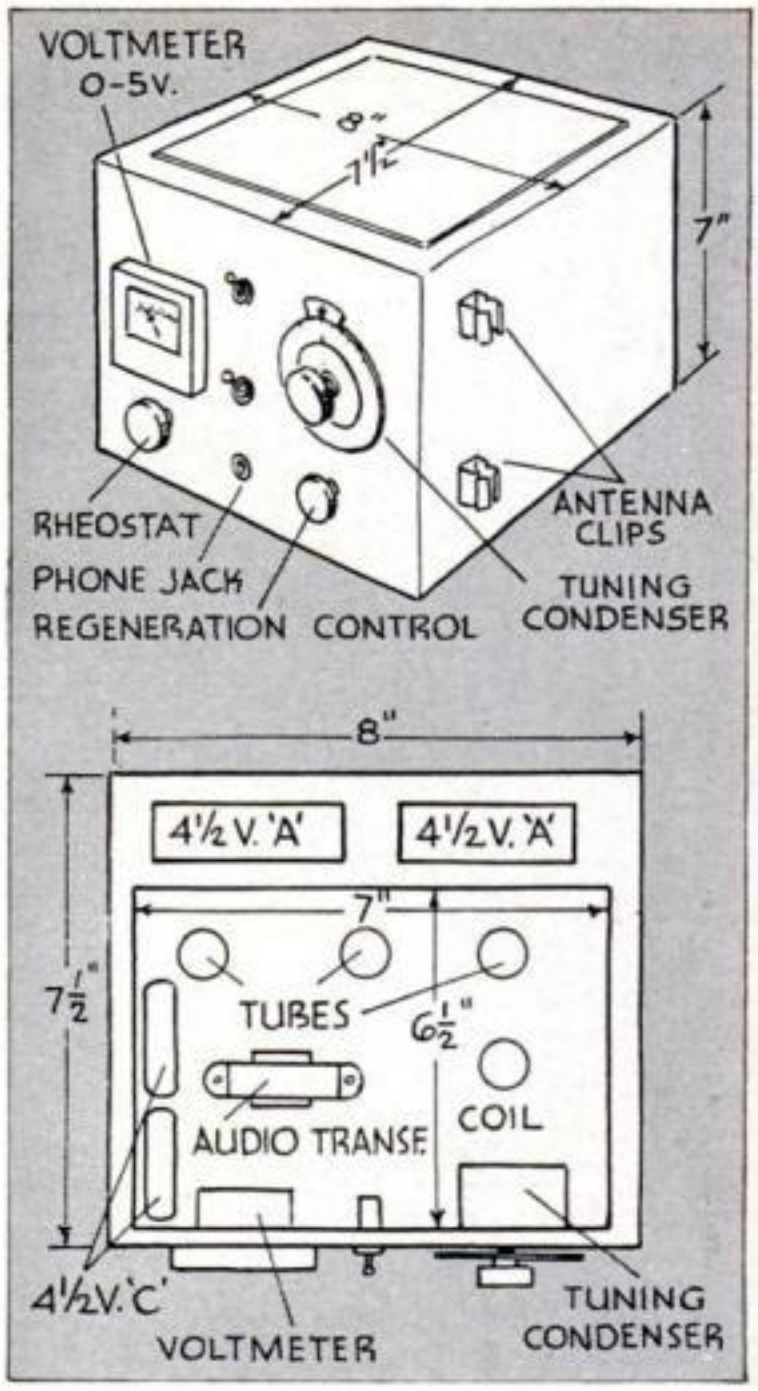
the set should fail to oscillate on a particular band, this may be remedied by increasing the capacity of the variable condenser used for regeneration to .00036 or by increasing the number of turns on the tickler winding. It should be noted that the coil specified by the manufacturer for use as the tickler winding is used instead as the antenna winding.

Batteries and headphones can be housed in the metal carrying cabinet. When the operator is ready to use the set, he merely removes the headphones from the case and plugs them into a jack on the front of the panel. Two inexpensive luggage straps, purchased from the five-and-ten-cent store, can be placed around the cabinet for carrying purposes.

The antenna consists of a telescopic metal rod similar to those used on cars. It is clipped to the cabinet next to the tuning condenser when the set is in operation. The clips must be fully insulated from the metal cabinet, which is connected to the ground circuit.

If the receiver is operated within 20 or 30 miles of a transmitter, it will work efficiently without a ground connection. For distant or weak stations, however, a ground must be used. A suitable ground can be made by connecting 5′ of insulated wire to a metal rod about 5″ long and 1½″ in diameter. The wire should be connected to either the front panel or the chassis and the rod inserted in the ground.

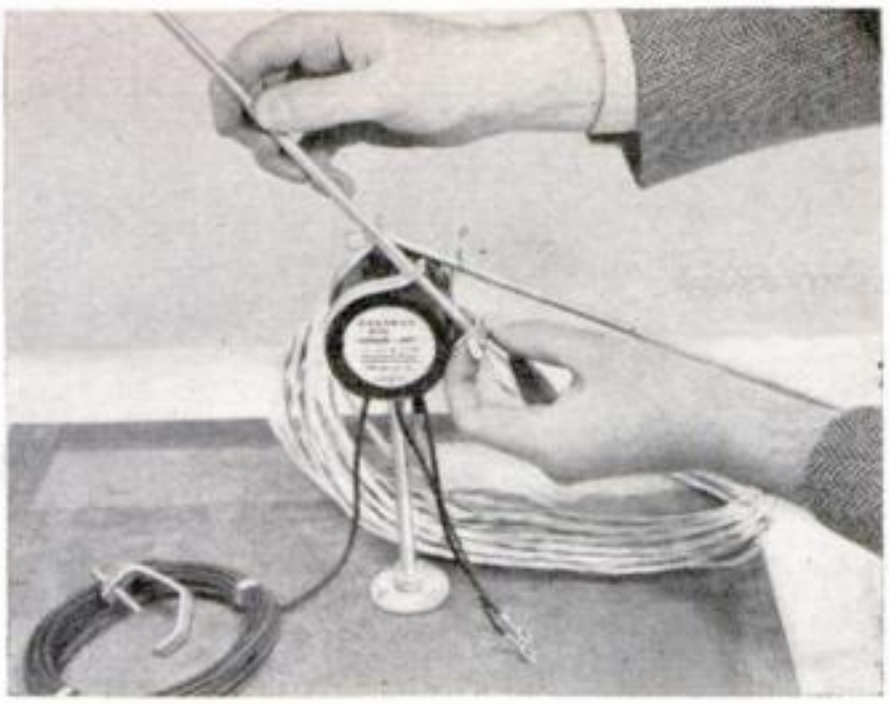
The emergency receiver shown in the illustration was constructed for about $15, but changing conditions in the radio-equipment field make it impossible to give any definite figures on cost. The set has been tested under adverse conditions where reception was faint on similar radios and has given excellent results.

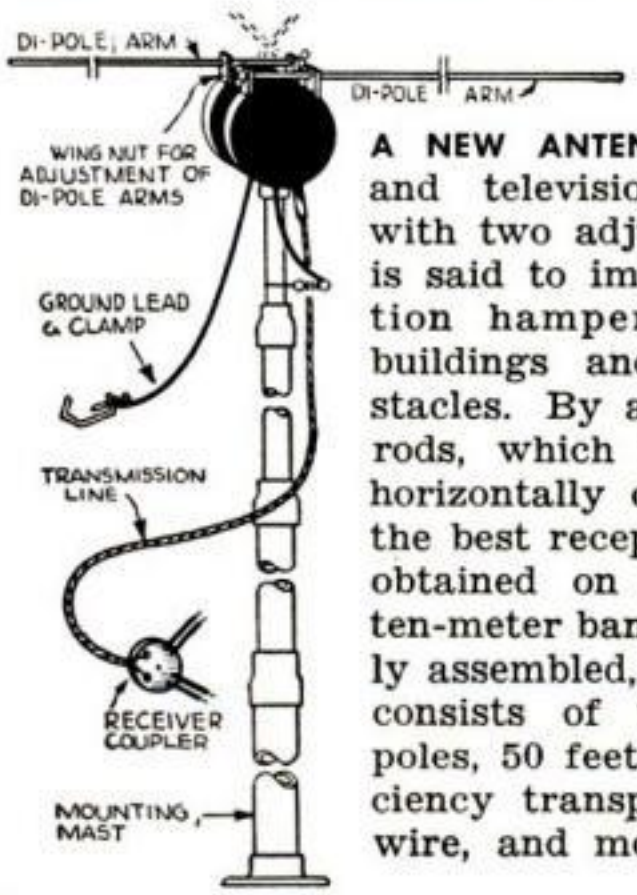



## LIST OF PARTS

Black wrinkled steel cabinet, 7″ by 7½″ by 8″.
Cadmium-plated steel chassis, 2″ by 5½″ by 7″.
Telescopic chrome-plated antenna.
Tuning dial, 2¾″ diameter.
Octal wafer sockets (3).
Six-prong coil socket.
Six-prong broadcast and short-wave coils.
Tuning condenser, .00036 mfd. or .00014 mfd.
Regeneration condenser, .00014 mfd. or .00036 mfd.
Audio transformers (2), unshielded, 1:3 or 1:5 ratio.
Ground clamp and wire.
RF choke, 2.5 millihenrys.
Rheostat, 10-15 ohms.
Voltmeter, 0-5 volts.
Toggle switches (2).
Phone jack and plug.
Mica condenser, .00015 mfd.
Carbon resistor, 2 megohms, ½ watt.
Midget "C" batteries (2), 4½ volts.
"A" battery, 1½ or 4½ volts.
Pentode amplifier tubes (3), 6SJ7 or 1SA6GT.

# Radio Ideas

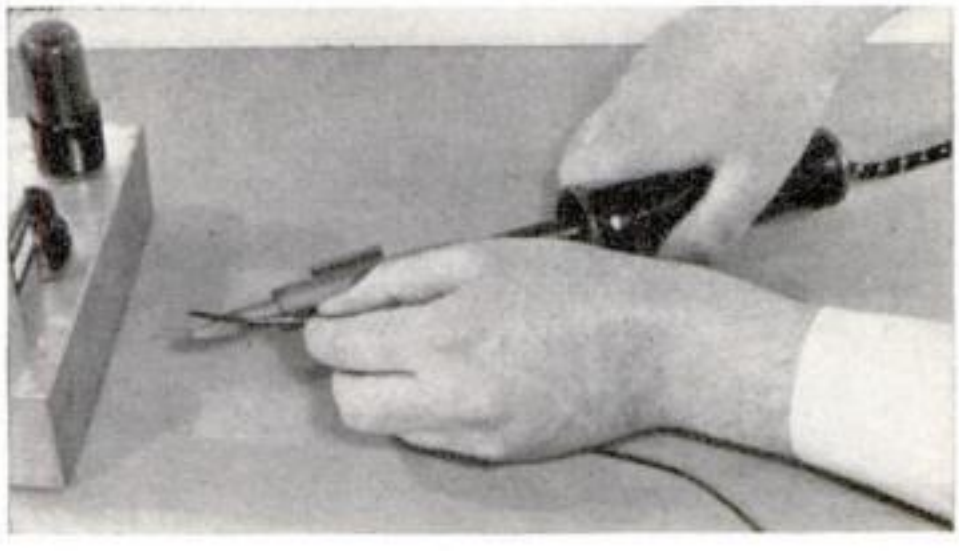





**A NEW ANTENNA** for FM and television, equipped with two adjustable rods, is said to improve reception hampered by tall buildings and other obstacles. By adjusting the rods, which move either horizontally or vertically, the best reception may be obtained on the five or ten-meter band. Completely assembled, the antenna consists of the two dipoles, 50 feet of high-efficiency transposed lead-in wire, and mounting pole.

**SIXTY-FOUR TONAL COMBINATIONS** can be heard on the new Zenith FM radio by operating six organ-type keys in different combinations. Known as the Radiorgan, this device allows the listener to accentuate low and high notes at the same time. In addition to FM, the radio provides standard and short-wave reception and is equipped with an automatic record player.

**CHANGING NEEDLES** is unnecessary on the new RCA table-model radio-phonograph shown at the left. Entirely automatic, the machine plays 12 ten-inch records or ten 12-inch records by pressing the starter button after the records have been loaded. A new-type pick-up with a permanent needle is said to reduce the pressure on the record surface, making disks last longer. The radio employs six tubes, has a three-point bass and treble tone control, an automatic volume control, and tone compensation.



**CHLORINATED RUBBER INSULATION** that uses 40 percent less raw rubber than standard coverings of the same dielectric strength, has been developed to cover flexible stranded wire. The new insulation is made in two types: one is self-stripping at the touch of a soldering iron, as at right, and the other merely softens when very hot.

## EASY EXPERIMENTS EXPLAIN

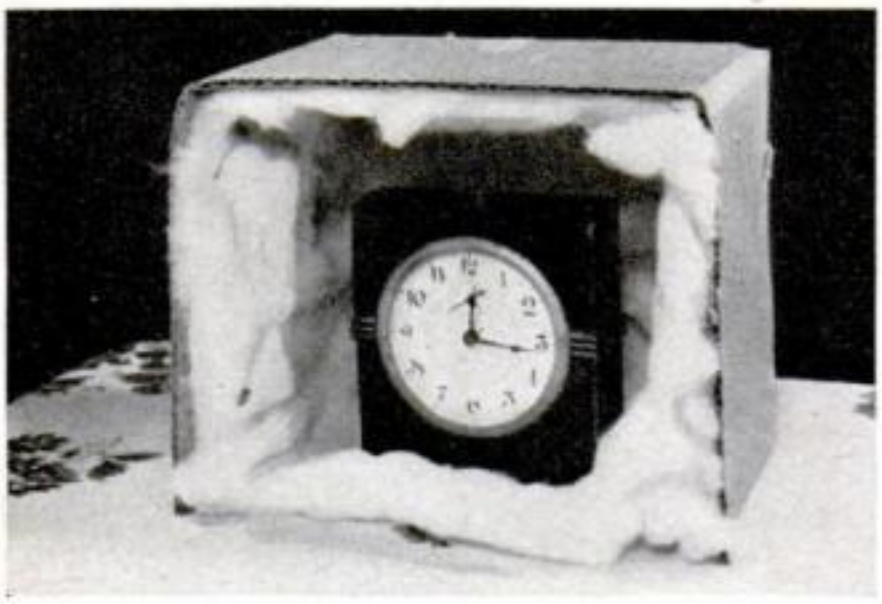
# SOUND WAVES

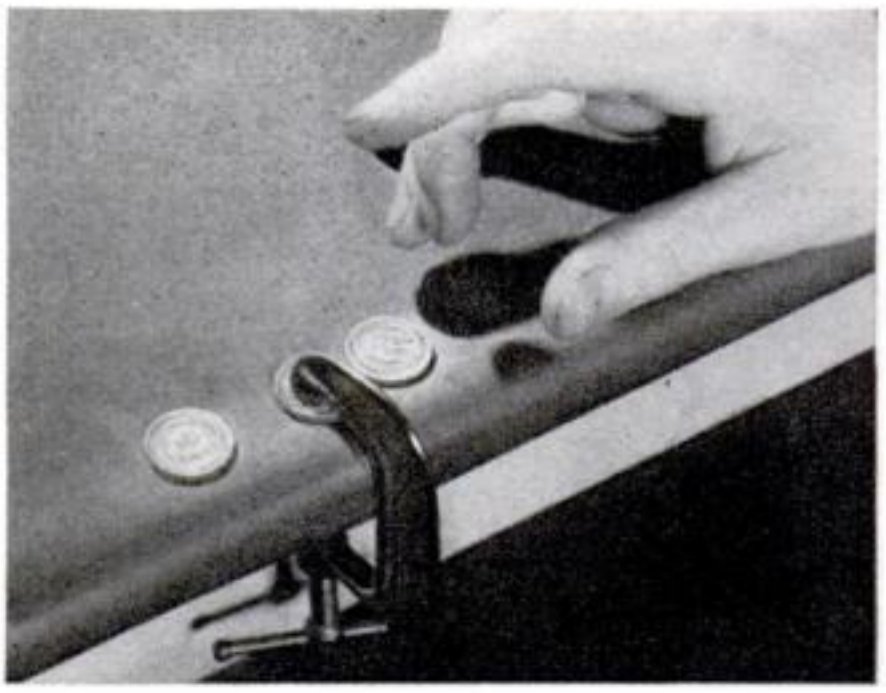
SOUND, to the home experimenter, has the advantage of being something tangible. Unlike light, it consists entirely of vibrations of air or other material substances. Its pulsations take place forward and backward, not transversely, along a line between the source and the observer. For all its simplicity, however, sound may be made to per-

## SCIENCE STUNTS

**SOUNDS CANCEL EACH OTHER.** Connect two equal lengths of rubber tubing to a glass T tube. Hold their open ends near a watch, and the stem of the T tube to your ear. You will hear the ticking distinctly. Now clip small pieces from one of the pieces of tubing, "listening in" each time as at left. The sound will diminish, becoming faintest when the tubes differ in length just enough for the crest of a sound wave to arrive through one at the same instant that the trough of a sound wave comes from the other, blotting out both.

**CONTROLLING ACOUSTICS.** How radio studios and auditoriums control sound reverberations may be demonstrated with a cardboard carton, cotton batting, and a clock. Set the open carton on its side, stand the clock within it, and find how far away you can hear the ticking. Now pack the space around the clock with cotton, as illustrated below, and you will find that the sound carries to a much shorter distance. By applying more or less absorbing material to the walls, the desired sound reflection is obtained.





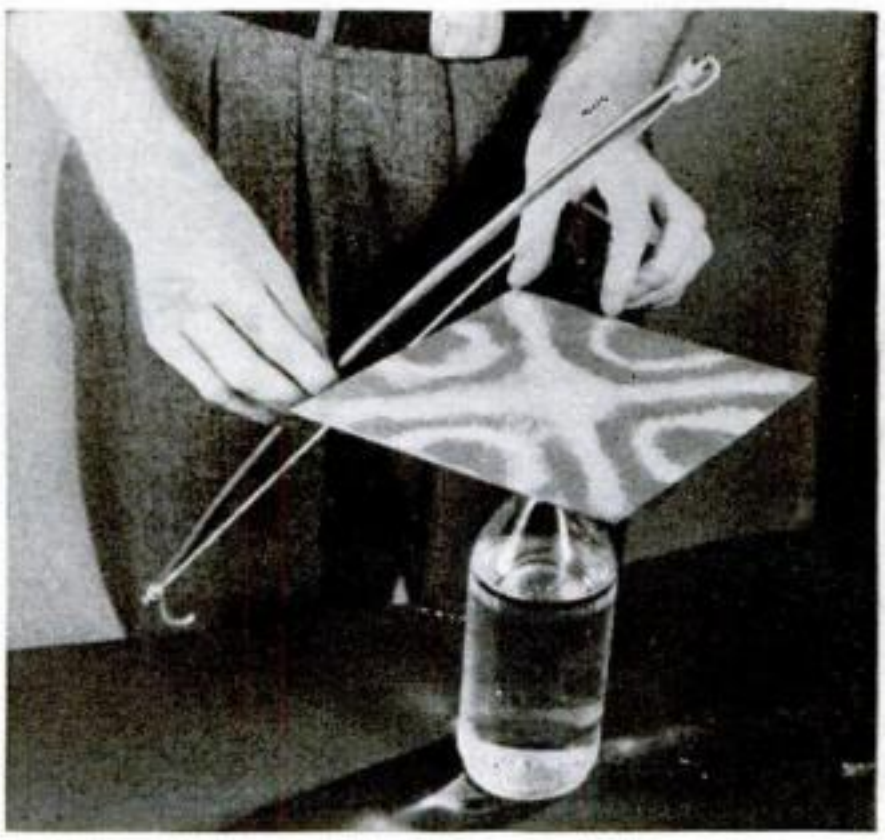
**HOW SOUND TRAVELS.** Clamp a coin securely to a table. Place another at its left, just touching it. From the right, snap a coin sharply against the clamped one. The center of the anchored coin does not move a fraction of an inch, but its rim vibrates with force enough to fling away the left-hand coin, as pictured above. Likewise, materials transmit sound without being carried along.

form engaging tricks in an amateur laboratory. Only the least of apparatus is required to show how a pair of sounds can destroy each other; studio methods of sound control; strange geometrical pictures drawn by sound; the principles applied in such musical instruments as the trombone and cornet; and other queer facts about sound, as demonstrated in the experiments on these pages.

**HOMEMADE TROMBONE.** Select two test tubes, of which one slides smoothly within the other. With a file, cut off the bottom of the inner one, and slip it into the larger tube. Blow across its mouth, and you will hear a musical tone. The pitch will fall as the tubes are drawn apart, and rise as they telescope together. The slide of a trombone, by lengthening or shortening the column of vibrating air, serves a similar purpose. In a cornet, finger-operated valves replace a moving slide, to direct air through the desired length of tubing.

**BONES REPLACE EARS.** Sound need not come through the air, and enter your ears, for you to hear it. To prove this, fasten a piece of thin wire about your head, as in the picture above, or hold one end of it in your teeth. Attach a phonograph needle to the other end of the wire. You may now play a phonograph record and hear it clearly, even though you place your fingers tightly in your ears. Transmitted through the bones of the head, the sound vibrations agitate the nerves of the inner ear in practically normal fashion. Apparatus based on this "bone conduction" principle has been developed to restore the hearing of persons whose deafness is due to impairment of the delicate mechanism of the outer or middle ears.

**MAKING SOUND DRAW PICTURES.** Strings of a violin or mandolin vibrate in simple patterns, but bells, cymbals, and other vibrating plates oscillate in complex ways that vary with their shape and the manner of striking them. Fine sand, sprinkled on a square plate of thin metal or glass, traces interesting designs when the plate is fastened to a bottle cork at its center and bowed at one point or another along its side. Touch the edge with one or two fingers, and the pattern may be changed at will. In these "Chladni's figures," as they are known, the sand is shaken away from vibrating parts, and heaps up at "nodes" or stationary parts. One of the many odd designs obtainable is illustrated below.



# Learn About SULPHURIC ACID

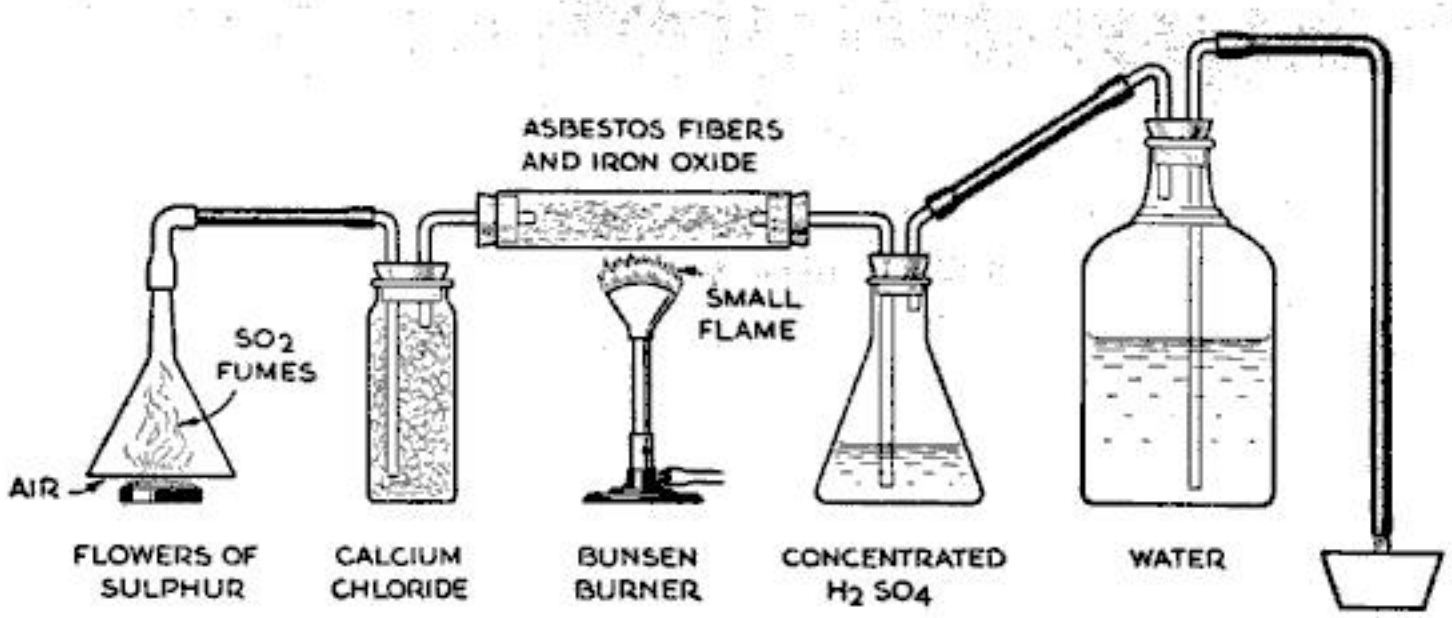
THIS chief among the chemicals that keep the wheels of America's war industry turning can be made right in your home laboratory. It is sulphuric acid, highly versatile and with distinctive properties that have earned for it the title, "King of the Chemicals." And it is as simple to manufacture commercially as you will find it to be with a few odds and ends of bottles and jars on the kitchen table.

**WARNING**

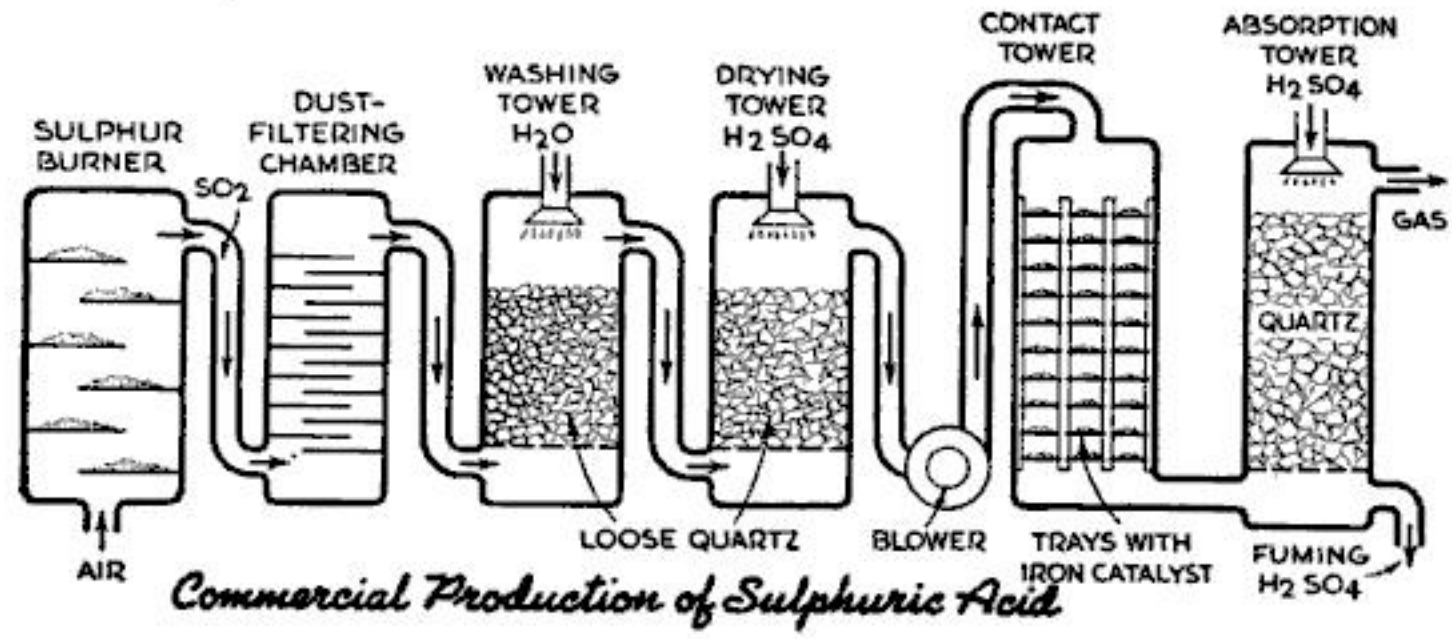
NEVER pour water into concentrated sulphuric acid. They will boil and spatter over the room. This is caused by the acid's great affinity for water. The only safe way is to *pour the acid into the water,* stirring constantly. Likewise, concentrated sulphuric acid will draw water out of the skin, leaving a dangerous burn.

Essentially, sulphuric acid is a thick, oily, water solution of sulphur trioxide. Concentrated acid is made commercially by the "contact" process in which sulphur dioxide, produced by burning sulphur or roasting iron pyrites, is passed over a heated catalyst, which causes it to combine with oxygen of the air to form sulphur trioxide. Since the finely divided sulphur trioxide cannot be dissolved directly in water, it is added to concentrated sulphuric acid, forming a superconcentrated or "fuming" acid which is easily diluted to the required strength.

You may demonstrate this "contact" process in your kitchen laboratory, with the simple apparatus shown. Your sulphur dioxide producer is a tin-can cover on which you burn a few grams of flowers of sulphur. This gas is collected by an inverted funnel held just high enough for air to come under its rim. Tubing carries the sulphur dioxide to the bottom of a pickle jar filled with lumps of calcium chloride which filter and dry it. For a catalyst, moisten a little as-




Sulphuric acid can be made in your home laboratory with odds and ends like the apparatus on the facing page, shown in diagram above. Commercial manufacture by the "contact" process, illustrated schematically below, is essentially the same



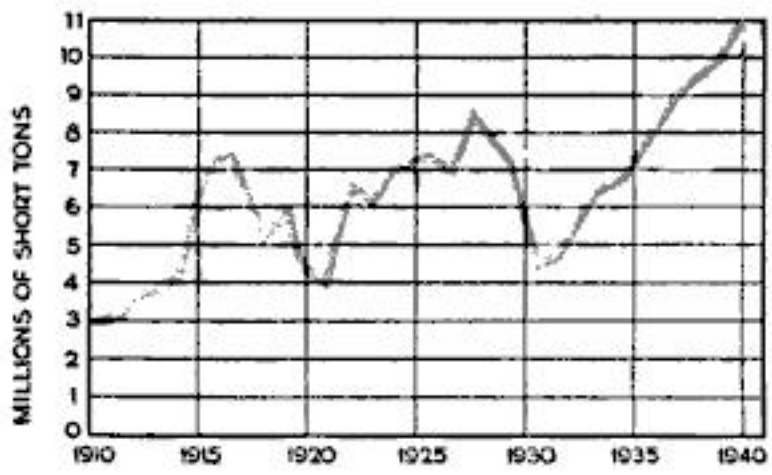

*Commercial Production of Sulphuric Acid*

# —No. 1 War Chemical

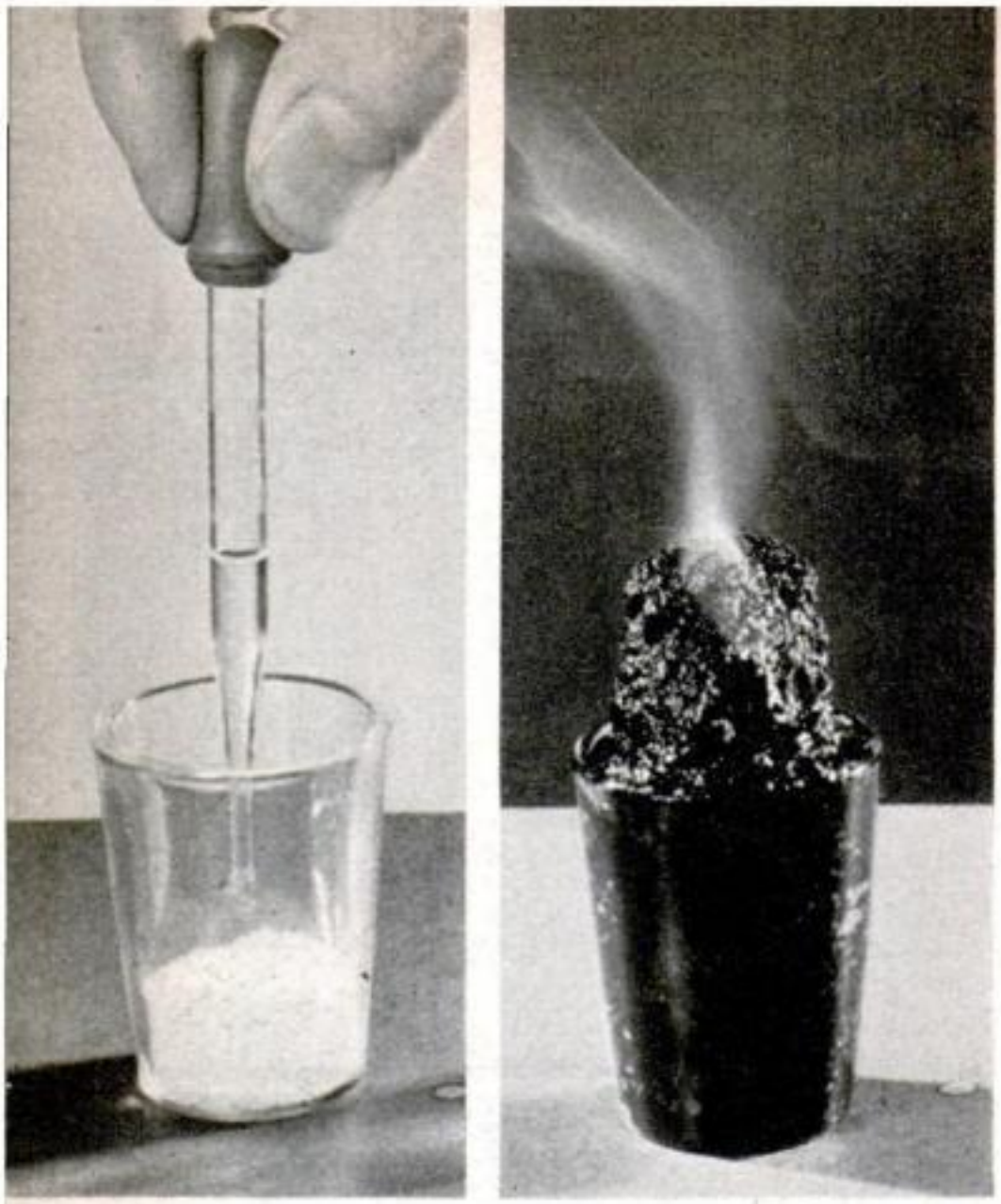
bestos fiber and shake it with a quarter of its bulk of iron oxide. When thoroughly mixed, dry in an oven and pack loosely in the glass tube which is arranged horizontally in your setup. The remaining flask contains concentrated sulphuric acid. The half-gallon jar is a siphon bottle which draws the gas through.

The Bunsen burner must be adjusted for gentle heat or the sulphur trioxide will decompose again. A marked increase in the concentration of the sulphuric acid in the flask occurs in a few minutes. By adding it to water—in diluting, always *pour the acid into the water*—you get a greater quantity of acid of the original strength.

Sulphuric acid is used in making many other acids. As an example, nitric acid—tremendously important in manufacturing explosives and cellulose films—may be made in your home laboratory, but use a glass retort as nitric acid reacts on cork and rubber. Through a paper funnel, drop 25 grams of sodium nitrate into the retort. Carefully pour 20 cc. of concentrated sulphuric acid on the nitrate. Arrange the retort with its stem extending into a test tube immersed in ice water and its bowl resting on a square of wire gauze with an asbestos center. When the crystals are thoroughly




Sulphuric acid production is a good barometer of business. The chart above shows the manufacture through 1940. Because war work requires the acid in huge quantities, the index line will go higher



One important property of sulphuric acid is its affinity for water, which it extracts from many substances. Here acid, dropped on sugar, boils and swells it into the charred mass at the right

moistened, heat the retort gently, distill at a low temperature until no more vapor condenses, and then allow to cool. The drops of liquid in the test tube will be pure nitric acid. HANDLE WITH CARE!

An important property of concentrated sulphuric acid is its eagerness to absorb water—a property employed to dry gases which are bubbled through and to remove water formed during chemical reactions. This dehydrating action can be demonstrated by dropping sulphuric acid on sugar. The mixture boils, then blackens and swells.

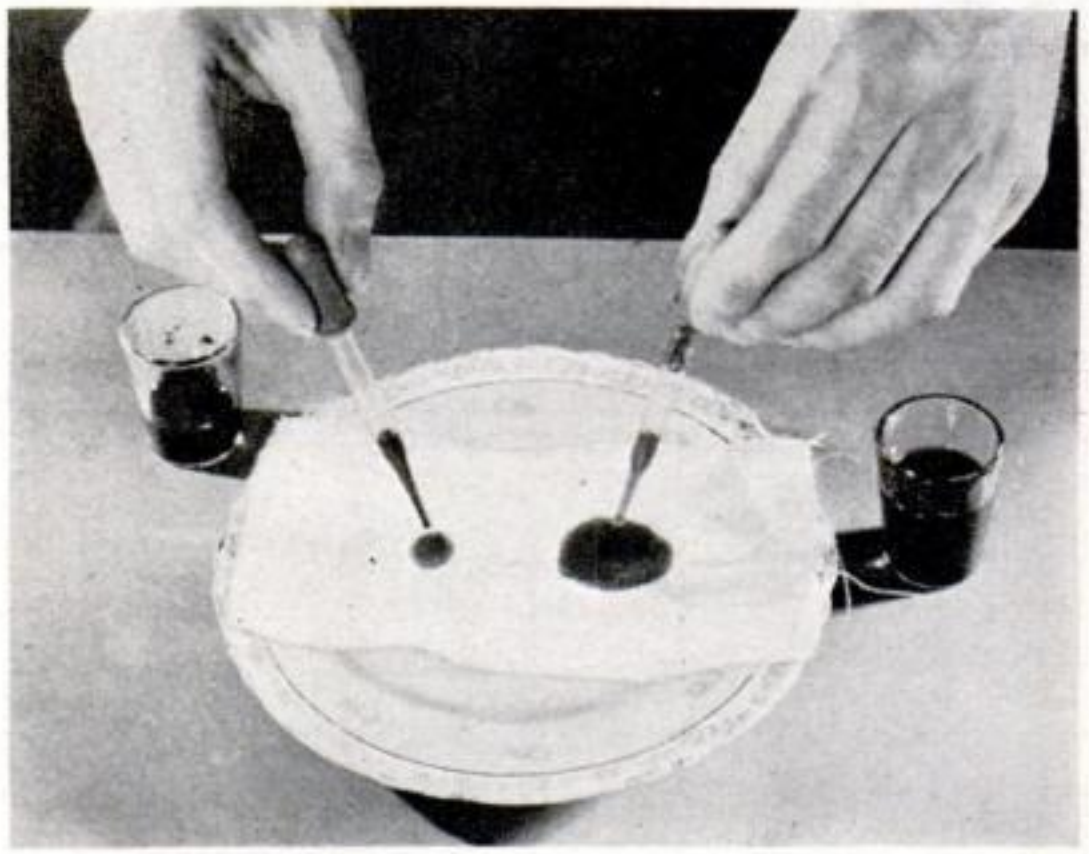
Dilute acid does not absorb water, however, and this may be shown by an amusing "stunt." Write with it on a piece of paper, and the writing will be invisible. Heat the paper, and the lines become visible as the water evaporates and the concentrated acid chars the paper.

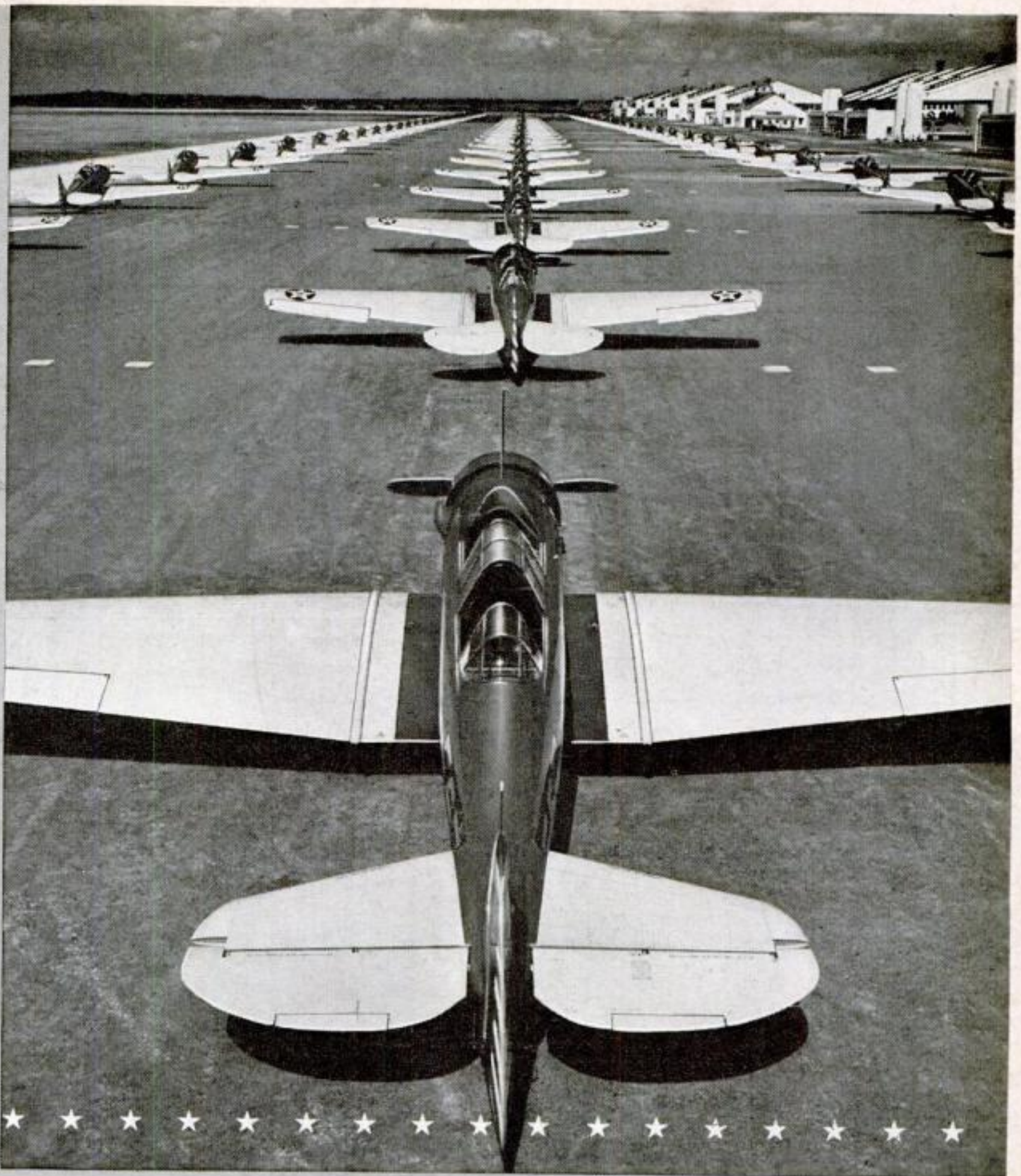
Dilute sulphuric acid acts differently from concentrated in several ways, and, strangely enough, is often more active. Drop a little dilute acid on a piece of clean zinc or iron and it "attacks" the metal instantly, forming a sulphate and furiously releasing bubbles of hydrogen. Use cold concentrated acid and little or no action occurs. Heat the metal, and the concentrated acid will oxidize it and then form a sulphate.

One of the greatest uses of sulphuric acid is in the production of fertilizers. In 1941, nearly a fourth of the total production was applied to this purpose. Phosphate rock, as found in the earth, is practically insoluble and of no use to plant life. Treatment with sulphuric acid changes it into soluble calcium phosphate, a valuable plant food. Two other important uses, in storage batteries and in electroplating, derive from its high electrical conductivity.

Shake a little sulphuric acid with an equal amount of castor oil or olive oil, and the result is a thick dark-reddish material called Turkey-red oil, which is used in the dyeing industry as a "wetting agent" to make dyes penetrate more evenly and easily. Having molecules which are partly attracted to water and partly to oil, it lowers the surface tension of water, spreads more readily.

Turkey-red oil, important in the dyeing industry as a "wetting agent," is made by mixing olive oil and sulphuric acid. A dye solution containing it spreads better than plain dye and water as shown at right



## PATTERN PICTURE—1942

Photograph of low-wing BT's (basic trainers), made at Randolph Field, Texas, by Master Sergeant Albert L. Barr. 1/50-second; K-2 filter; *f*/16; Kodak Super-XX Film. Kodak Super-XX is a high-speed panchromatic film widely used both for indoor photography and for outdoor work under adverse light conditions or at high shutter speeds. Rolls, packs, sheets.

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**THE GREAT PICTURES ARE MADE ON KODAK FILM**

# Precision Bombing Takes Teamwork

*(Continued from page 107)*

leaves the bombing to the bombardier. It is the bombardier who arms the bombs, opens the bomb-bay doors, and drops the bombs. The mission accomplished, the pilot listens for two spoken words: "Mission complete."

Until then, everything is in the bombardier's hands. In a very real sense he is in command of the ship while he sights and bombs. The pilot works for him.

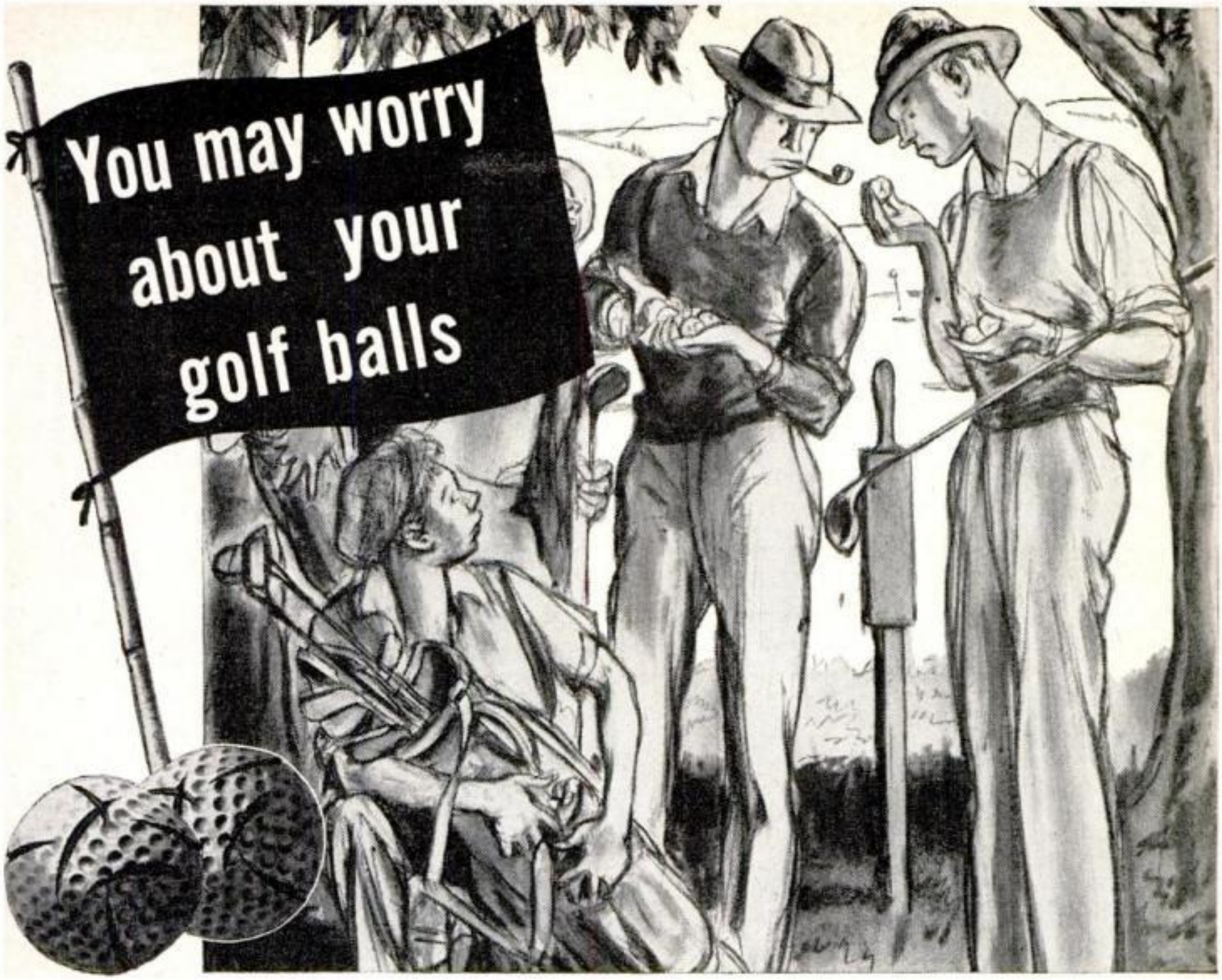
At this point everyone in the plane is concentrating on one specific purpose—to help the bombardier to hairbreadth accuracy. The gunners may be blasting away at enemy pursuits, the pilot coolly keeping the plane on its steady course, the copilot filling in for the pilot's needs without being told, like a good private secretary. If any one fails, it is failure for all.

All warfare is national teamwork. An army is a team made up of combat teams. And there is nothing new about the necessity for teamwork in a bomber. In the German air force, if one man of a bomber crew is lost, the whole crew goes back into training, out of action until its new member has been broken in. That is the ideal we strive for in our own Air Forces, too.

Our own Air Forces are perfectionists. Up until a couple of years ago a pilot had to have 2,000 hours of military time before being intrusted with the controls of a Fortress. Today Fortresses are being flown by downy-cheeked boys, and there will be thousands more of those kids on the job before long. To multiply the Air Forces within a year or so, far more than a hundredfold, will necessitate speeding up the old principles. But one thing they can't afford to compromise. That is the necessity for these young and experienced men, pilots, navigators, bombardiers, radiomen, and gunners, to break in together and form cohesive groups which work together smoothly, understand each other perfectly, who operate like nine musketeers—"all for one and one for all."

Plenty of men in the first World War were given instruction right behind the battle lines, in how to use their rifles, and went into action without ever having fired a practice shot. Perhaps some of these untrained men were 50 percent effective.

But you can't get away with that, flying a heavy bomber. If one man fails, it's a 100 percent failure for nine men and a priceless combat machine.




# ...but here is one worry you can avoid

GOLF BALLS, or automobiles—today they've got to *last longer.* That's why king pins, tie rods, drag links, bearings and other vital friction points require the *extra* care, the *superior protection* of stem-to-stern Marfak chassis lubrication every 1,000 miles.

Marfak helps add miles to your car's life because it's super-tough. Applied by chart—not by chance—it resists wear-out, wash-out and squeeze-out.

For your peace of mind, don't say "grease job." Insist on genuine Marfak 40-point Lubrication Service. At Texaco and other good dealers everywhere.

**TUNE IN:** FRED ALLEN every Sunday night. See your local newspaper for time and station.


*You're Welcome at* **TEXACO DEALERS**

# Inventor for Victory

*(Continued from page 92)*

the first facsimile message across the Atlantic, a hand-written greeting to his father; and in 1927, using high-frequency neon lamps and a perforated scanning disk, he staged the first home reception of television at his own home in Schenectady. A few months later, on January 13, 1928, he gave the first public demonstration of the new wonder. In recent years Dr. Alexanderson has devoted himself largely to the power applications of the electronic science, such as power transmission with direct current. But he has also found time to design single-phase motors for railway electrification, to make important contributions to radiant energy guiding systems for aircraft and automatic steering of both air and water craft, and to develop countless applications of vacuum tubes in power transmission, rectifiers, inverters, and frequency chargers.

As far as public knowledge is concerned, Dr. Alexanderson's career stopped short with the invention of the amplidyne, an extremely sensitive and powerful system of amplification and automatic control, which he, with M. A. Edwards and others of the General Electric Consulting Engineering Laboratory, developed about the time that the United States began to think seriously of rearming. Like so many discoveries which have been adapted for war, the amplidyne was designed for peacetime use, specifically in steel mills and other plants requiring delicate control of continuous operations. Long before the Japanese attack upon Pearl Harbor, however, it had been successfully applied to the firing of antiaircraft guns, which must be subject to split-second control if they are to hit airplanes traveling at more than 400 miles an hour. Dr. Alexanderson himself has said that the amplidyne can be used for "almost anything" that moves under power, a generalization which would obviously include torpedoes, airplanes, tanks, and other war machines. The details of all actual and possible applications of the amplidyne, as well as of the work now under way in Dr. Alexanderson's laboratory, are military secrets.

Dr. Alexanderson is utterly unlike the popular conception of a scientist; he resembles a successful business executive more than he does a man who devotes his life to exploring the secrets of electricity and frolicking in the higher branches of mathematics. He looks ten years younger than his 64, and though his hair is thinning he still has plenty of it, and neither it nor his little

*(Continued on page 206)*

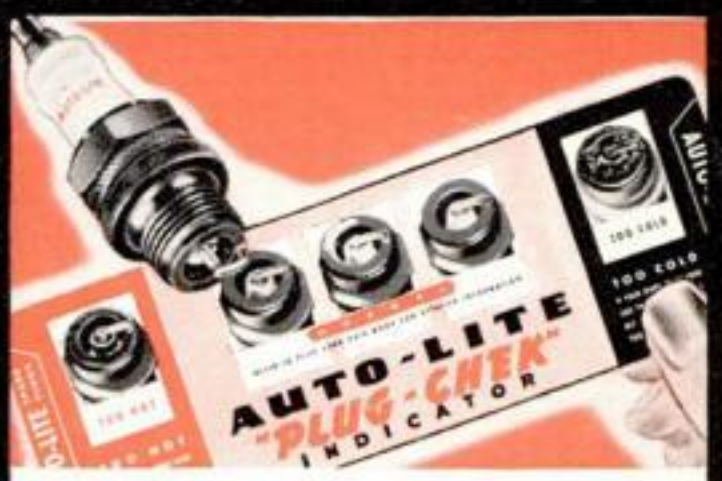
# AUTO-LITE SPARK PLUGS

*Presents the* MOUNTAIN BOYS *by* P. WEBB

"SHECKS, ONCLE TIGE--IT'S STILL TOO DERN GOOD FER THE HAWGS --- WITH SOME WHEELS ON 'ER AN' A FEW NEW AUTO-LITE PLUGS SHE'D RUN LIKE A DAISY"

## GET "LIKE-NEW" PERFORMANCE FOR SPARK WEARY ENGINES...

The Mountain Boys are right—these days cars must be kept in service. Car owners find new Auto-Lites give flashing pick-up and power, restored gas economy to spark-weary engines. To discover if your present plugs are the reason for hard starting, lack of power, ask for a "Plug-Chek." Simply cleaning and regapping your present plugs often makes your car run like new.




Color and condition tell if plugs are operating properly. Matching your plugs with those illustrated on the "Plug-Chek" is the first step in getting new life for spark-weary engines.

THE ELECTRIC AUTO-LITE COMPANY
Toledo, Ohio · *Merchandising Division* · Sarnia, Ontario

In its 26 Great Manufacturing Divisions, Auto-Lite is Producing for America's Armed Forces on Land, Sea and in the Air

# Inventor for Victory

*(Continued from page 204)*

close-cropped mustache is as gray as his age would lead a visitor to expect. His eyes are brown and alert, and in them there is an expression of quizzical kindness which has reminded many people of Thomas A. Edison. He wears a sack suit by preference, and although his trousers are not always perfectly pressed, the general effect is one of neatness and precision. He reads a great deal, knows what is going on in the world, and likes to discuss it; and he possesses the rare knack of being able to describe his own work in terms so simple that even the average man can sometimes understand what he is talking about. He walks two miles to work every morning in the winter, and in summer labors diligently at his favorite hobby, sailing on Lake George, in upper New York. It used to be considered unsafe to sail on this narrow, gusty body of water, but the tradition died in 1928 when Dr. Alexanderson brought over a North Sea pilot boat and sailed it all one summer without mishap. Now Lake George has a yacht club with 30 boats, and Dr. Alexanderson is as proud of having been its first Commodore as he is of the many honors bestowed upon him for his scientific achievements.

One of the most peculiar things about Dr. Alexanderson is the fact that he is not in the least peculiar. Although he is a bit absent-minded, he is a man of remarkably few idiosyncrasies. In fact, the only trait he possesses that might be called an idiosyncrasy is his apparent liking for keys. In his right-hand trousers pocket, on the end of a largish chain secured to his belt, he carries a bunch of keys and appliances, including can and bottle openers, as big as a grapefruit. And attached to the key ring is the first thing that Dr. Alexanderson ever bought in America, a circular slide rule somewhat larger than a silver dollar, which he picked up in a New York shop the day he landed. It is the only one of the kind he ever saw, and it is his most prized possession. When he wishes to use it, or to select one of his numerous keys, Dr. Alexanderson yanks the whole bunch from his pocket with a flourish. It usually falls to the floor with a considerable clank, and he hauls it in hand over hand as if it were a pickerel.

Dr. Alexanderson's greatest ambition is to contribute materially to the defeat of America's enemies. But he also has another though minor ambition. He would like to meet Greta Garbo.

"But I suppose," he said, "she's pretty hard to meet."

# Readers Win 32 Prizes for Ingenuity in Using Salvaged Tin Plate

MORE THAN 500 entries were received in our recent contest challenging readers to find new uses for tin plate salvaged from cans and other containers. Many of these entries displayed remarkable originality and craftsmanship. So keen was the competition that, after selecting the first and second prize winners, the judges found four entries tied for third prize. Four ten-dollar prizes were therefore awarded instead of one as announced in the contest rules. The number of one-dollar prizes also was increased from 15 to 26.

FIRST PRIZE, $50
R. Nino, Eagle Pass, Texas

SECOND PRIZE, $25
Dr. W. C. Ballard, Denville, N. J.

THIRD PRIZE, $10

A tie among James A. Carl, Tucson, Ariz.; O. Edward Culver, Rochester, N. Y.; Frank J. Pizarro, New York, N. Y.; Louis Nicolosi, Kansas City, Mo. Each was awarded $10.

TWENTY-SIX $1 PRIZES

Twenty-six prizes of $1 each were awarded to the following: Wray W. Becking, Port Jervis, N. Y.; William J. Catallo, Elizabeth, N. J.; Wilbur Coss, Clairton, Pa.; Franklin P. Cressman, Bethlehem, Pa.; Harry D. Fee, Muskegon, Mich.; Michael Ferro, Chicago, Ill.; Fred Gottwalt, Lake Placid, N. Y.; George Habig, Alhambra, Calif.; E. B. Haffner, Baltimore, Md.; Violet Hogie, Watertown, S. Dak.; Harold Jackson, Kankakee, Ill.; Edward Kiehl, Buffalo, N. Y.; G. A. Leiter, Akron, Ohio; Mario Losasso and Carmelo Caltabiano (joint entry), Brooklyn, N. Y.; Robert Meyer, St. Paul, Minn.; M. Meyerson, Jacksonville Beach, Fla.; Henry Nordstrom, Elma, Wash.; H. A. Paar, Jackson, Mo.; H. C. Rose, Carbondale, Ill.; John Rouch, Wind Gap, Pa.; Ralph G. Smith, Newark, Ohio; Eugene Steidemann, St. Louis, Mo.; V. D. Stevens, Hillsdale, Mich.; Galen Stutzman, Adrian, Mich.; Louis Terry, Lake Odessa, Mich.; George R. Utting, New Rochelle, N. Y.

The entries included toys, picture frames, birdhouses, one footstool, a model of the *Queen Mary,* a colorful basket full of flowers, a model railway bridge, a toy diver operated by dry ice, an HO-gauge freight car, and many other ingeniously designed articles. Some of the most interesting projects will appear in forthcoming issues of POPULAR SCIENCE.

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## HARDWARE DEALER

CONSERVATION • SERVES EVERYONE •

**48 Pages • 200 Illustrations**

Packed with useful workshop advice, instructive pictures, practical helps and hints. Contains this statement from George T. Weymouth, Bureau of Industrial Conservation, War Production Board: "TOOLS ARE WEAPONS. CONSERVE THEM. USE THEM PROPERLY TO AVOID BREAKAGE AND THE WASTE OF CRITICAL MATERIALS NEEDED TO WIN THIS WAR."... Make your tools last longer. Get your FREE copy of the Disston Saw, Tool and File Manual from your Hardware Dealer.

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# TEST-O-LITE

**Tests Everything Electrical From 100 to 550 Volts**

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MOTORS

FUSES

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A real necessity for electricians and home because it has 1001 uses. Equipped with a Neon light which tells instantly where trouble lies in electric circuits, fuses, cut-outs, motors, radios, all kinds of electric appliances, etc. Tells A.C. from D.C. Far superior to ordinary clumsy test bulb. Fountain pen size with clip for carrying in vest pocket. Lifetime guarantee.

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**L. S. BRACH MFG. CORP.**
**53 Dickerson St., Newark, N. J.**

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**FOR 27,000 R.P.M. INSIST ON A GENUINE**

# MOTO TOOL

**100 Tools in One**

- Has shock-proof bakelite case
- Fan-cooled motor can't overheat
- Has oil-less bearings
- Dynamically balanced armature

Here's guaranteed quality! The handiest tool in the shop or home. Use it daily for model making, repairing, carving wood or plastics, etching glass or metal, touching up dies, sharpening, routing, sanding, drilling, and on a hundred other jobs. Higher speed does better work and saves cutters. **Model One,** wt. 6 oz., with chuck and 1/8" collet, only $9.95. **Model Two,** wt. 13 oz., $16.50. **10 DAY TRIAL—Money-Back Guarantee.** If your dealer does not have Moto-Tool, order direct . . . we pay postage if you send cash. Or, send only $1, pay postman balance plus postage. New catalog of tools and accessories **FREE.**

KIT NO. 1 with 23 high grade accessories and Model 1 Moto-Tool in hardwood case **$17.50**

KIT NO. 2 same as above with Master Model 2 Moto-Tool.... **$23.50**

**DREMEL MFG. CO.**
**Dept. T122-G**
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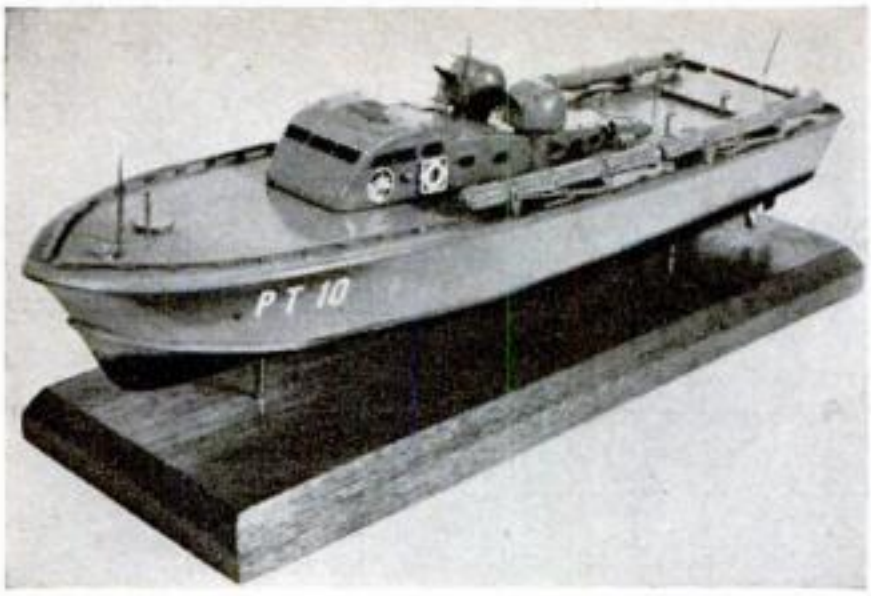


## Mosquito-Boat Model Built from Construction Kit

FIGHTING ships are in the limelight now, and not to be overlooked are those audacious little motor torpedo boats called the "Mosquito Fleet." Above is shown a 3/16" scale model of one of these, the P.T. 10, built from our construction kit 13S, which is priced at only $5.00†, postage paid. This unusually complete kit includes a shaped hull, finished propellers, struts, torpedo tubes, machine-gun barrels, and all other fittings and materials needed. The finished model is 13" long.

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| E. | Battleship U.S.S. TEXAS, 3' long, scale 1/16" equals 1' | 7.95* |
| V. | Clipper SOVEREIGN OF THE SEAS, 20½" hull, 26" overall. Kit includes anchors, flags, bell, capstan, brass ladder | 5.35† |
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# America's Artillery Might

*(Continued from page 60)*

on a carriage of the split-trail type, which affords a wide traverse without shifting the mount. The weapon is easy to aim and operate. It is normally designed for visible fire and direct laying or aiming: the gunner, that is, has direct control of the weapon and does not rely on any mechanical device to do the pointing for him. The rate of fire is 15 to 20 rounds a minute under combat conditions.

The 37-mm. gun is effective against light tanks. It cannot stop medium and heavy tanks unless it scores a hit through an open port, or damages a tread or track suspension. For protection against these larger tanks a 75-mm. gun is needed. The biggest tank so far built can be disabled by a well-placed shell from a 75-mm. gun.

When mounted on a tank chassis or half-track weapon carrier, and provided with a shield for the crew, either the 75-mm. or 37-mm. gun is called a "tank destroyer." The combination really constitutes a tank in which armor protection has been sacrificed for lightness and speed. Such a vehicle must traverse rough terrain, plow through soft places, ford streams, climb out of ditches and shell holes, and in general cover ground almost like a horse. The chassis must not be so low that it will strike ordinary obstructions, nor so high that the body will present an easy target. The power plant must be big, the armor as heavy as possible, yet the combination must not be too heavy to get around with speed and certainty.

As of the end of 1941, an American tank-destroyer battalion equipped with this type of artillery comprised 24 armored half-tracks mounting 3-inch guns, 18 "jeeps" mounting 37-mm. guns, and ten light tanks. The 3-inch cars carry a crew of four men and a two-way radio installation, have a gross weight of 17,500 pounds including the crew, and are capable of 50 m.p.h on a good road—and they don't hesitate to get off the road. The engine is 147 h.p., geared for eight forward and two reverse speeds. The driver can stay in place when the gun is fired. The elevation and traverse of the 3-inch are the same as on the standard mount—nothing is lost when it is set on the half-track.

The jeeps, mounting 37-mm. guns, are of a number of types, some with the gun facing forward, others rearward. The crew usually consists of a driver, gunner, and loader. The vehicle is underslung, with a

*(Continued on page 212)*

# Build Your Sailboat Now for Fall Vacation Fun

GLORIOUS days on the water can be yours with our 19′ cruising sailboat. It's a cozy, sea-going home, yet it can be carried on a two-wheel automobile trailer. Use an outboard engine, or let the free wind take you places! Blueprints and instructions are only $2.00. Full-size patterns are drawn to order within ten days at $3.50 for the set. Both blueprints and patterns will be sent for $5.50.

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Lapstreak Skiff, 13′ 9″ long, weighs 225 lb., for 1- to 16-h.p. outboard motors, 363-R..... .50
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# America's Artillery Might

(Continued from page 210)

very low silhouette to make it hard to hit.

A jeep or an armored half-track might take a shot with ordinary gun sights at a low-flying plane and bring it down, but that would be something to write home about. For antiaircraft work, special guns and aiming means are employed, because the target is moving so rapidly that the unaided human eye and brain are inadequate. The essential difference is in the method of fire control—of which more later—rather than in the gun itself. Thus the antiaircraft battery can be and often is used against tanks and armored cars with great effectiveness. In fact, the service regulations require the crew to be prepared for such operations. But, while an AA gun automatically becomes an AT gun when the muzzle is pulled down and it is aimed by eye, an AT gun cannot be used for AA fire unless it is especially equipped for that service. We now have some 37-mm. guns on half-track carriers which are so equipped and can be switched instantaneously from AT to AA shooting.

The standard sizes of AA guns in our Army at the present time are 37 or 40-mm., 3-inch, and 90-mm. for mobile service. Still larger guns are being manufactured for use in semifixed emplacements. As always, the design requirements conflict. An AA gun should have a high rate of fire, high muzzle velocity, as straight a trajectory as possible, the lowest possible time of flight, and large bursting area for the projectile. But as the size of the gun increases the rate of fire drops. Likewise, high muzzle velocity requires a thick-walled shell, which reduces the burst effectiveness. Mobility calls for a small gun and high-altitude effectiveness for a big one. The result is that no one gun will fulfill all the requirements, and several calibers and types are necessary to do the job right.

For low-flying planes—say up to 5,000 feet—the 37-mm. or 40-mm. gun is reasonably effective. The latter is the famous Bofors funnel-shaped design which has been thoroughly tested in Europe. It is fully automatic and fires up to 120 rounds a minute. The projectile weighs 2.2 pounds and will explode on contact with an airplane wing. The muzzle velocity of 2,850 feet per second gives the gun a virtually straight trajectory to a range of about 9,600 feet. The weight of the gun happens to be the same as that of the 105-mm. howitzer—4,300 pounds—and it can be put into

(Continued on page 215)

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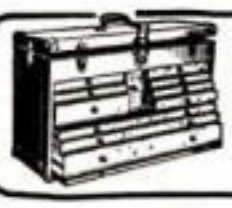

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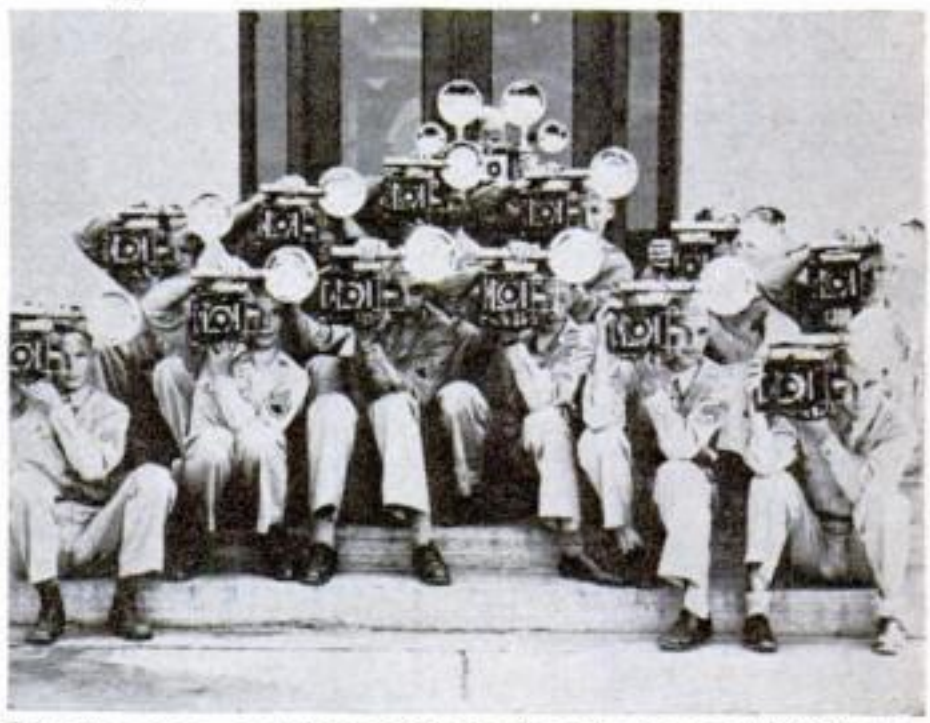

**Graduates,** and into Uncle Sam's Army Air Corp. They're experts now, ready for work high behind enemy lines . . recording secrets with their cameras.

# America's Artillery Might

(Continued from page 212)

action within half a minute after arrival.

The next larger caliber, 3 inches, makes a much heavier AA gun—12,000 pounds—but one which is still readily transportable. Set up, the gun, mount, and working platform rest on four sectionalized outriggers or horizontal girders laid on the ground. This contrivance folds up for transportation and takes from seven to ten minutes to emplace. The muzzle velocity is almost as high as that of the Bofors, but the rate of fire is down to 25 rounds per minute. On the other hand, the projectile weighs over five times as much—12.7 pounds. A gun of this caliber is reasonably effective up to 15,000 and possibly 18,000 feet. It is valuable in the field and for protection of targets requiring precision bombing.

The data on the larger AA guns, 90-mm. and 4.7-inch, is restricted. However, it is safe to assume that our 90-mm. is superior to the German 88-mm. gun, which fires 20 rounds per minute and has an effective altitude of about 25,000 feet. The 90-mm. gun travels on a single-axle trailer, towed by a six-ton truck. It is the largest mobile size in AA guns. The 4.7-inch is too heavy to be considered fully mobile. A gun of this caliber, intermediate between the 105 and 155-mm. field piece, is heavy and expensive to build, and expensive to fire, but one of its shells may dispose of a plane several hundred feet from the bursting point, and the bursting point is somewhere up in the substratosphere. Where a gun like this is emplaced, the bombers fly high and bomb less accurately, if they bomb at all.

When guns shoot at fast-moving targets like airplanes, the great problem is in connection with the things that are going to happen while the projectile is in flight. You have to figure where the target will be at a given instant in the future, and send the shell to that point. But you have no time to figure. In a few seconds the opportunity is gone. So you have to get a machine to do the figuring for you. You tell it what you know about the gun, the projectile, the target, and a lot of other things, and the machine gives you the answer.

One thing the machine cannot do, however, and that is to make the decisions. That is still a man's job. The greater the extent of military mechanization, the more important intelligence, will, initiative become. And in these qualities the artillery arm ranks high. There is nothing more important than artillery in this war—unless it is the artilleryman.


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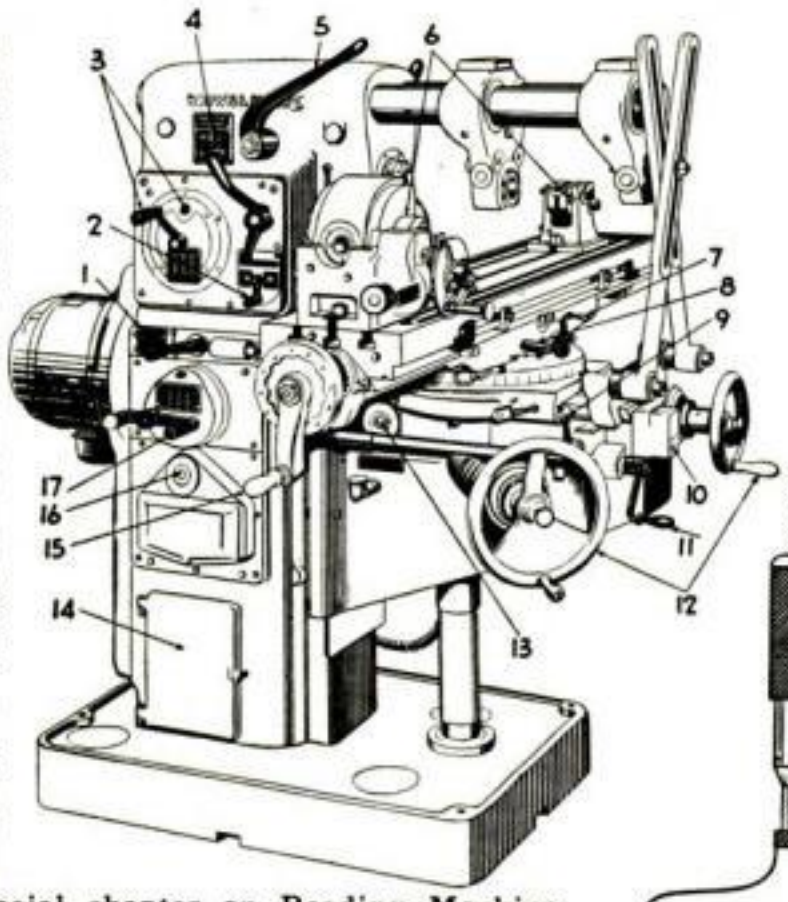


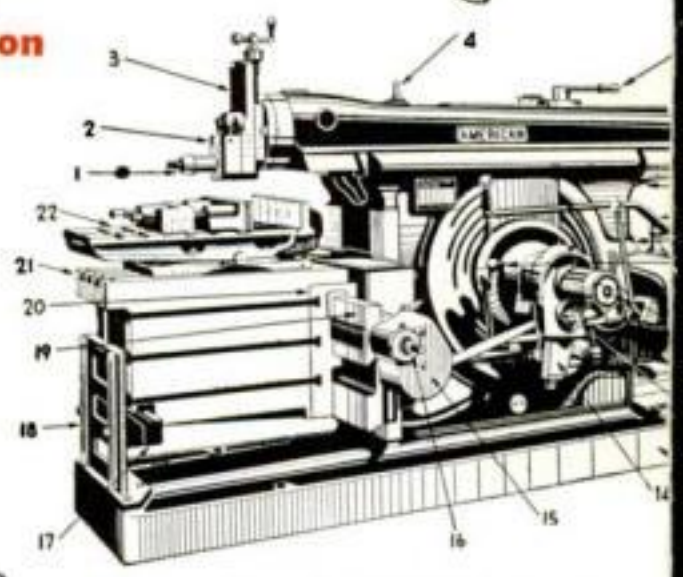


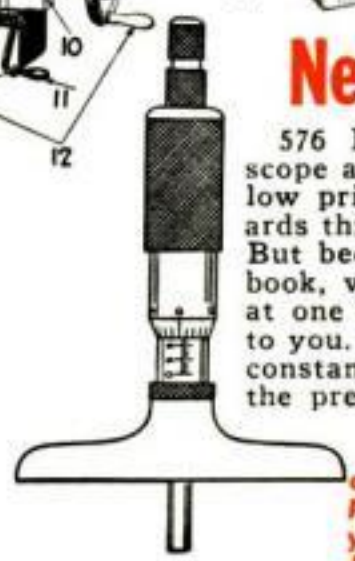

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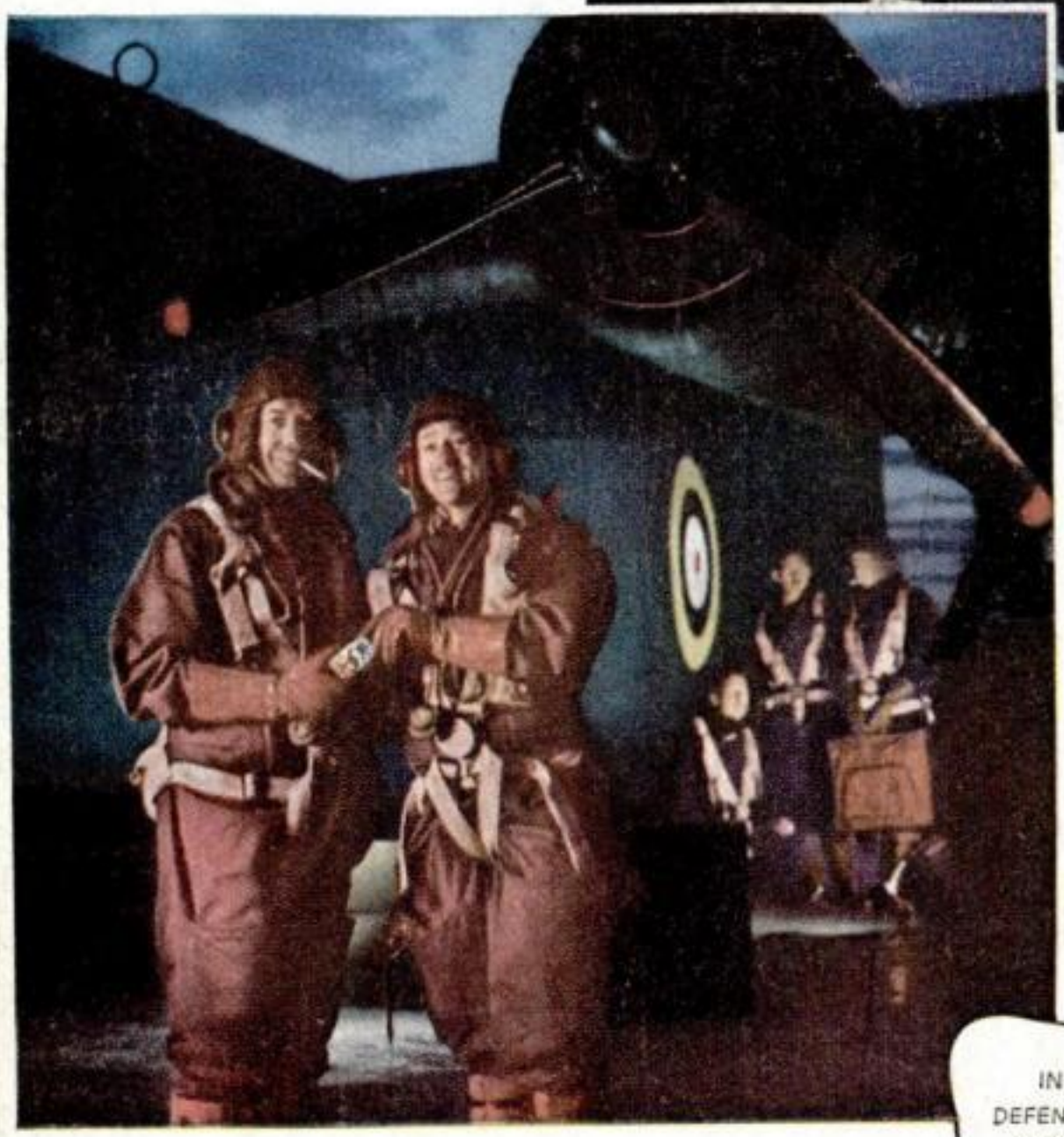

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